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DISPERSION STUDIES ON THE DELAWARE RIVER ESTUARY MODEL AND POTENTIAL APPLICATIONS TOWARD STREAM PURIFICATION CAPACITY EVALUATIONS

Interstate Commission on the Delaware
River Basin

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JUNE 1961

STUDY COMMITTEE

Delaware State Water Pollution Commission
Interstate Commission on the Delaware River Basin ✓
New Jersey Department of Health
Pennsylvania Department of Health
Water Department, City of Philadelphia
U. S. Public Health Service, Region II

ACKNOWLEDGEMENTS

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Mr. C. F. Wicker of the Corps of Engineers, Philadelphia District, has afforded timely advice on numerous occasions to help expedite the completion of this study.

Last but not least, the Committee wishes to acknowledge in particular the work of Dr. A. J. Kaplovsky and the staff of the Water Pollution Commission, State of Delaware. Dr. Kaplovsky reviewed the pertinent literature and has been responsible for planning the studies and developing the techniques used in obtaining the basic data. He and his staff have worked long and diligently to co-ordinate, evaluate and compile the vast amount of information contained in this report.

FOREWORD

The following report is indicative of the co-operative efforts of the three states bordering the tidal section of the Delaware River to study and evaluate pollution in the Delaware River estuary.

This study has been a joint venture of the Delaware State Water Pollution Commission, the Interstate Commission on the Delaware River Basin (Incodel), the New Jersey State Department of Health and the Pennsylvania Department of Health. These organizations financed the program of experiments conducted on the model of the estuary located at the U. S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.

The Philadelphia Water Department made funds available for Model Tests 13 and 14. These tests were considered an important addition to the experiments and have been included in the report.

A study Committee, composed of representatives of the Delaware State Water Pollution Commission, Incodel, the New Jersey State Department of Health and the Sanitary Water Board of the Pennsylvania Department of Health, was formed to develop the test program, co-ordinate and evaluate the data, and organize the preparation of the report.

The Committee invited representatives of the City of Philadelphia and the U. S. Public Health Service, Region II to attend the several meetings of the group as observers. Their unofficial observations and suggestions were both helpful and appreciated.

The report is presented in two parts. Part one describes the tests performed, co-ordinates the data and evaluates the results of the extensive studies of the dispersion of simulated pollution discharges into the Delaware River estuary. This was done by the use of dyes discharged at various locations and at different flows in the model of the estuary. These experiments were designed to correlate with, and make useful to this study, other related experiments in the model which have been made previously by other agencies.

Part two contains a potential application of the findings of the model studies to the results of a number of prototype pollution surveys of the river estuary made by the Delaware State Water Pollution Commission and other participating agencies.

Substantial information on basic principles involved in pollution assimilation in the tidal estuary, indicated a need for more extensive research in the various aspects of pollution assimilation in such a body of water. The Committee believes the report forms the basis for, and will stimulate, more comprehensive research in the dispersion patterns and assimilation capacity of pollution of the Delaware River estuary.

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CHAPTER I

GENERAL INTRODUCTION

During the past five to ten years, added emphasis has been placed upon the need for knowledge with regard to the pollution recovery capacity of estuaries. This need may be attributed to several reasons. The increasing rate of industrial growth and population in the Coastal States of the Northeast, the Pacific and the South has emphasized the need for cleaner estuarine waters, especially in areas where the potentialities of recreation are reasonably great. The increase of pollutional loadings in estuarine waters attributed to this growth and development has begun to emphasize its presence in downstream areas, heretofore unaffected by the various discharges. In addition, pending water shortages and the need for multiple use, have placed added emphasis upon water quality.

Certain complexities and variables inherent in estuaries make the understanding of waste stabilization in such environments considerably more difficult to comprehend than in areas or streams subjected to one directional flow. Similarities do exist in many estuaries; however, variations in width, depths, configuration and run off make it almost impossible to transfer completely, knowledge from one estuarine study to another. In essence, each tidal stream must be given separate consideration since the dispersion characteristics which affect the movement of the waste discharges are essentially different and/or specific accordingly. Fortunately, or unfortunately, as the case may be, some coastal streams are less complex with regard to stratification, lateral dispersion and other factors. Before one can intelligently evaluate waste stabilization in any tidal stream, a knowledge of the dispersion of a discharged material must be reasonably well known. It would be futile to attempt the application of known stabilization theory to a waste which is discharged into a system when little is known with regard to its dispersion and/or distribution characteristics.

There have been several proposals and theories set forth in the literature with regard to dispersion or circulation formulae for estuaries. Unfortunately, these proposals or theories have some application only in a specific estuary where the procedure was developed. It seems logical and reasonable that in order to resolve a pollution recovery problem in a given area, that it might not be necessary to develop a method or procedure that is applicable to all tidal streams. If a solution could be developed for a specific problem, it would certainly be of significant value to that area, even though it may not have universal application.

Considerable effort of past research on estuaries has been directed towards providing a universal solution. In many cases, the solution to the more difficult variables has tended to create differences in the theory of solution among the various researchers. However, a closer scrutiny of the effect of these difficultly solvable variables upon the overall pollution problem has shown that in some areas, little of the overall problem would be resolved if and when the complicated aspects were completely understood. If the rapid growth and development in the Delaware River Valley, and possibly in other similar areas, should continue, it is more important to the stream pollution administrator to have a solution to a present problem which represents a large majority of the loadings and resultant decomposition, rather than to await a complete solution which may or may not be resolved in an indeterminate period of time. It is indeed possible and reasonable that many of the variables and complications existing in other estuaries are not present in the Delaware River Basin. Consequently, the knowledge of the dispersion characteristics may be developed in a more expeditious manner by tentatively excluding or setting aside the solution to relatively minor influences.

In 1956 the British, in a study of the Thames Estuary, had developed a formula for dispersion within this stream. The basis for this formula is largely dependent upon data collected since 1880. Obviously, we do not have such information nor do we have the infinite patience of the British to duplicate their experience. However, we are fortunate in having a model of the Delaware River at Vicksburg, Mississippi which has been used by the Corps of Engineers and others to study various problems relating to the distribution of conservative materials. Unfortunately, these studies on the Delaware River Model were not designed to resolve the effect of a pollutional material of a nonconservative nature. In 1952 and again in 1956 the Delaware Water Pollution Commission had observed through various sanitary analyses that the Delaware River had certain characteristics of regimentation, which could be potentially taken advantage of in a study of pollution stabilization, to the extent that a large portion of the total pollutional load is confined to waters 20 feet and deeper. It had been estimated that this represents more than 90% of the total pollutional load in the Delaware River estuary. The significance of this finding is evident in that it tentatively removes the pressure for a time consuming study of the effect of the many variables which, in essence, could resolve the problem of the remaining ten percent or less of the total pollutional load. It appeared logical to assume that if a solution to the pollution problem involving or representing ninety or more percent of the total load could be resolved, it would certainly be a practical method for the time being of handling many of the critical problems of the present and of the near future.

This observation of regimentation within the Delaware River as evidenced by the sanitary analysis made by the Delaware Water Pollution Commission is not new. A study of the various Corps of Engineers reports made on the Delaware River Model shows that the Delaware River is essentially a shallow stream with very little or no stratification. Further, the experimenters at Vicksburg have been sampling the deeper waters of the Model as representative sampling points in their various studies of movement within the Delaware River estuary for many years.

The numerous studies made by the Corps of Engineers and others did not fully cover the various points of information needed to resolve distribution problems completely on the Delaware River estuary. Further, the Corps of Engineers studies had been confined to instantaneous release experiments which are not consistent with the continuous type discharge of pollution which exists in most localities. Fortunately, however, in 1956 the duPont Company, and later in that year the New Jersey Zinc Company, conducted continuous type experiments on the Delaware River Model. Their findings were of considerable interest and one of the initial hurdles relating to continuous type pollution discharge was overcome. It was deemed appropriate and of great value to extend these studies of the Corps of Engineers, the duPont Company, and the New Jersey Zinc Company in such a manner that certain dispersion and movement characteristics of the Delaware River could be established from Trenton, New Jersey to the Delaware Bay. If such dispersion information could be found, it could conceivably be used in the study of pollution stabilization. The many years of investigation and collection of information as was deemed necessary by the British for the Thames Estuary pollution evaluation might be then avoided.

CHAPTER II

STATEMENT OF THE PROBLEM

The introduction just completed set forth in very general terms the motivation and reasoning which inspired the series of tests performed on the Vicksburg-Delaware River model as presented in this report. The Agreement, discussed in detail in another section, between the Interstate Commission on the Delaware River Basin, Pennsylvania Department of Health, New Jersey Department of Health, and the Delaware Water Pollution Commission, states the purpose of the project in the following manner.

"The purpose of the project is to secure additional information necessary or desirable for estimating the capacity of the Delaware River Estuary, extending from the head of tide at Trenton, New Jersey to the Delaware Bay at Liston Point, Delaware, to assimilate wastes discharged from sewage and industrial waste treatment plants and other sources including particularly:

(1) the dispersion characteristics under various flow regimes, and;

(2) the specific effects of various stream flows upon the dispersion and transit of continuously discharged pollutants into the estuary."

The Philadelphia Water Department made available funds necessary to defray the costs of Incodel Model tests 13 and 14. These two additional instantaneous dye release experiments in the upper reach of the Delaware River model were made in order to supplement and complete the information with regard to transit time.

The numerous Corps of Engineers studies on the model were performed under various conditions in order to secure information primarily with regard to salinity movement, sediment buildup and tidal fluctuations. These experiments were performed by making an instantaneous release of dye and following its movements through the various tidal excursions under controlled flow conditions. Many of the experiments were performed under mean flow conditions and occasionally at high flows of approximately 40,000 cfs as recorded at Trenton. The existing experimental data accumulated by the Corps of Engineers are comparatively meager with regard to areas upstream from Allegheny Avenue.

The duPont studies were confined to an area in the lower reach of the Delaware River between the Pennsylvania-Delaware state line and downstream to the Bay. These experiments were performed and discharges were made in a continuous manner and were, to the best of our knowledge, the first of such studies to be conducted on the model at Vicksburg. However, the duPont experiments were performed under flow conditions beginning with 5,000 cfs and upward. Further, the duration of the experiments was comparatively short to demonstrate the buildup of pollution in the lower reach of the Delaware River where transit time is unusually long. Additional data were needed to complete these buildup patterns (29) in this lower reach of the river.

The New Jersey Zinc Company's studies which involved additions of dye in a continuous manner were performed under low flow conditions. In fact, one test was conducted at 2400 cfs for an extremely long time period of 240 cycles. However, the New Jersey Zinc Company experiments were conducted specifically to establish movement of contaminant upstream and measurements were confined to upstream areas with very little emphasis on downstream movement of the contaminant.

Both the duPont studies and the New Jersey Zinc studies were made at different outfall locations to establish the effect of each of these variables upon the contaminant dispersion.

In summation, the experiments performed on the Delaware River model by various investigators prior to the INCODEL studies supplied only a portion of the information desired to establish a more complete understanding of the dispersion characteristics of the Delaware River estuary. Information was still lacking with regard to transit-time for the entire stream; ultimate buildup levels, specifically in the lower reach of the river; and the buildup and movement under various stages of flow. Dr. L. L. Falk, of the duPont Company, observed in their study work that during continuous discharge experiments, buildup within the tidal areas occurs in a manner which is very well expressed by the unimolecular equation (27). Even more significantly it was shown that an Analog Computer could be programed for the unimolecular equation and the various constants readily obtained. It was of particular interest to fully establish the findings and observations made from the duPont studies.

A further examination of the duPont experiments by the Delaware Water Pollution Commistion indicated the possibility that the various constants derived from the unimolecular buildup of continuous discharge material results in a specific and definite relationship from location to location downstream from the point of discharge. It was further observed that it was potentially possible this relationship existed not only from location to location but varied proportionally with flow. It became apparent that if the relationship of ultimate buildup values within the Delaware River were specific and could be defined by formulae, it would be a significant contribution to the understanding of dispersion of waste material within this estuary. Consequently, it was deemed desirable to establish under continuous discharge conditions the rate coefficients derived from the unimolecular buildup curves with regard to location and flow stage. Toward this end a series of experiments was decided upon which could meet this need.

Basically, the tests proposed would supplement and expand existing information derived from the Delaware River Model. This expansion is represented by the following:

1. Establish transit time for the entire estuary from Trenton to the Bay during different stages of fresh water flow.

2. Find the ultimate buildup concentration at various stations in the river measured at high and low water slack during different stages of flow, as indicated by inert substances (dye) discharged from a specific location.

3. The dye discharge points to be located at stations (Corps of Engineers locations) -100; +00; +50; +130; and +170, constituting a total of 5 different positions. These different positions were selected on a basis of information derived from unpublished prototype studies with regard to nitrogen buildup in the Delaware River. It had been found from prototype investigations on the Delaware River that 5 distinct plateaus representing organic loading areas exist within this drainage basin. It was, therefore, deemed appropriate to discharge in the model from locations at the center of these various plateaus.

4. The stages of flow to be studied were 3400 cfs; 4500 cfs; 5500 cfs; 7000 cfs and 8000 cfs as measured at Trenton.

A review of the existing Corps of Engineers data, both published and unpublished, indicated the continuity of transit time of discharges emanating from various locations. However, in view of the extremely important section, (Navy Yard Station +50) and upstream, pollution-wise, not being included in the above test series plus the unknown validity of transit time interpolations to these upstream areas during lower flows, further transit time studies were indicated for the upstream reach. Consequently, additional tests were needed. Dye concentrations and procedures used in previous model tests of the Corps of Engineers were repeated; however, the new discharge point was moved upstream to station +00. Trenton discharges of 3400 cfs, 7000 cfs and 12,350 cfs were the controlled flows employed.

Transit time measurements were considered complete when the center of mass had reached station +130 or until the 3400 cfs test "blended" with reported transit time curves of similar flow stage tested at downstream locations. The 7,000 cfs and 12,350 cfs test series were discontinued when the values became logically dispersed between the completed test series at 5,000 and 16,475 cfs (including the Schuylkill) already completed by the Corps of Engineers.

Establishing and performing the various tests to complete the information desired is naturally just part of the problem. Orientation and evaluation of mixing or dispersion characteristics were needed. It was desirable to determine whether a mixing coefficient relationship $X=L(1-C10^{-kt})$ exists from station to station in the river and whether coefficients for intermediate locations could be interpolated. Consequently, the ultimate buildup values derived from continuous waste discharge conditions during high water and low water slack must be known.

Since the deoxygenization coefficients for organic matter have not as yet been established for the various portions of the river, tests were continued for 180 cycles unless the ultimate buildup plateaus had been reached prior thereto.

In lieu of the potentiality that a relationship might exist and interpolation for intermediate values warranted, the following "reduced" program was initiated:

(a.) Perform a complete series of dye discharges; one in each of the five established sections, at the same Trenton flow of 3400 cfs or a total of 5 tests.

(b.) In the critical pollution area, the Navy Yard-Paulsboro, perform a test at station +50 with additional flows of 4500 cfs, 5500 cfs, 7000 cfs and 8000 cfs or an additional 4 tests.

This constitutes a total of 9 tests for the continuous phase, in lieu of a potential 25 tests if no interpolation were possible.

The transit time series were expanded from three to five tests. The two additional instantaneous release experiments were made upstream from Allegheny Avenue (+00) at Trenton, New Jersey (station -155).

Calculation of the various coefficients associated with the unimolecular buildup curves derived from the numerous experiments would have involved at least seven months of continuous calculation. Employing a Computer programed to this particular unimolecular formula and other formulae would save many months of valuable time in arriving at the coefficients desired. Consequently, computer time would be obtained and the various coefficients derived in a comparatively short time.

Upon completion of all of the above studies and evaluation one might consider the task completed. However, from the stream pollution administrator's point of view, application of the findings to actual stream conditions is an integral part. Therefore, another phase of the overall problem was to take the inventory of the pollution loadings collected for the entire Delaware River Estuary and insert this information into the various formulae of dispersion. Coupled with an understanding of stabilization rates of various waste material, a determination of whether or not resultant concentrations which were developed from these inventories were in agreement with the findings in the prototype had to be ascertained.

CHAPTER III

COORDINATION OF INTERESTS

During the summer of 1956, the Delaware Water Pollution Commission approached INCODEL with regard to its findings in the development of the "same slack" technique of sampling for pollution in tidal estuaries. The development experiments were performed in the lower reach of the Delaware River, downstream from the Pennsylvania-Delaware state line. Discussion was held with regard to the potentiality of extending this procedure for the entire length of the river to Trenton, New Jersey. This matter was brought to the attention of the Incodel Water Quality Committee and it was agreed as logical and reasonable to determine whether this procedure could be applied to the entire tidal area since it could conceivably collect valid information in a relatively short time.

Late in the fall of 1956, it was established through test runs that the "same-slack" procedure (16) could be extended to Trenton, New Jersey. Thereafter, during the summer and fall of 1957, 1958, and 1959 "same slack" studies on the prototype have been made. Studies were continued in 1960.

In order to make practical use of this information with regard to establishing the recovery capacity of the Delaware River estuary, it was readily apparent that information was needed with regard to dispersion of various constituents. Consequently it was agreed that the best available means to establish dispersion or distribution within this body of water was to employ the model of the Delaware River located at the Waterways Experiment Station in Vicksburg, Mississippi.

A special committee was formed for the model study and a visit to Vicksburg, Mississippi was made in order to evaluate and establish the potential availability of the model for the needed work. Since the Corps of Engineers, Philadelphia district, owned the model at Vicksburg, permission was requested and granted for the use thereof. This special committee consisted of representatives from the States of New Jersey and Delaware, Commonwealth of Pennsylvania, the City of Philadelphia, the Public Health Service Region-2, and INCODEL.

The tentative costs of the experiments were set forth by INCODEL and the financial participants were initially limited to INCODEL, Commonwealth of Pennsylvania, the States of New Jersey and Delaware. Since the initial financial commitments for the various tests, the City of Philadelphia had contributed funds to make two additional experiments considered important by the committee.

Before the experiments were begun, a complete outline of the various tests to be performed was made for the review of the committee. It was understood that the various compilations and interpretations would be initially drafted by the Delaware Water Pollution Commission and INCODEL staffs and submitted to the various members for review and comment. The various participants concurred with the following agreement:

AN AGREEMENT

For Making Tests in the Model of the Delaware River
At the U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi
For a Study of Dispersion Characteristics of the Delaware River Estuary

Being desirious of carrying out the Project herein described, the signatories hereof agree that:

I. Purpose of Project

The purpose of the Project is to secure additional information necessary or desirable for estimating the capacity of the Delaware River estuary, extending from the head of tide at Trenton, New Jersey to the Delaware Bay at Liston Point, Delaware, to assimilate wastes discharged from sewage and industrial waste treatment plants and other sources, including particularly:

(1) the dispersion characteristics under various flow regimes, and

(2) the specific effects of various rates of stream flow upon the dispersion and transit of continuously discharged pollutants into the estuary.

II. Methods to be Used in Project

The model of the Delaware River Estuary of the U.S. Corps of Engineers located at Vicksburg, Mississippi, will be utilized for this Project. The release of a dye (or several compatible dyes), in a manner established by the Waterways Experimental Station will be used as the mechanism for tracing tidal dispersion characteristics and transit time of the estuary.

III. Sponsorship of Proposed Study

A. The following agencies will sponsor the Project financially in the amounts set forth below:

Incodel	$ 5,000.
Pennsylvania Department of Health	7,500.
New Jersey Department of Health	5,000.
Delaware Water Pollution Commission	5,000. *
TOTAL	$22,500.

B. Funds provided by Incodel and the Departments of Health of New Jersey and Pennsylvania will be used only for the purpose of reimbursing the Corps of Engineers for the costs of the model studies proposed herein. * Services and funds provided by the Delaware Water Pollution Commission, aggregating at least $5,000, will be utilized for compilation, calculation and interpretation of data, and will include the allocation of $3,000 for the use of an Analog Computer.

IV. Technical Direction of the Project

A. The technical direction of the Project shall be the function of a Technical Committee composed of a representative of each of the agencies named in paragraph III above. It is agreed that a representative from the Philadelphia Water Department and a representative from the United States Public Health Service, Region II, will be invited to participate with the Technical Committee.

B. The Technical Committee shall supervise all phases of the model study and the reporting of the results of the Project. This Committee may delegate the supervision of any portion of its responsibilities including the actual tests at Vicksburg to one or more of its representatives. Representatives of any of the participants of the Technical Committee may be present at any Committee meeting or at the performance of the actual tests on the model of the Delaware River at Vicksburg. Travel and related expenses shall be borne by the individual's own agency.

V. Project Tests

A. General

Basically the tests will be designed to supplement and expand existing information and studies performed on the Delaware River Model in the following respects:

1. Establish transit time from station to station for the entire estuary from the Bay to Trenton, during different stages of fresh water flow.

2. Find the maximum concentration build-up, at various stations in the river measured at high and low water slack during different stages of river flow, of an inert substance (dye) discharged from a specific location.

3. The dye discharge points will be located at stations: -100; +00; +50; +130; and +170, constituting a total of five different positions.

4. Stages of flow to be studied will be 3,400; 5,000; 6,000; 7,000; and 8,000 cfs, as measured at Trenton.

B. Transit Time

1. Review of existing data indicates the "continuity of transit time" of discharges emanating from various locations. However, in view of the extremely important section, Navy Yard (station +50) and upstream, pollutionwise, not being included in previous test series, plus the unknown validity of transit-time interpolations to these upstream areas during lower flows, further transit-time studies must be performed for the upstream reach.

2. Consequently, the following additional tests will be conducted:

a. Similar dye concentrations and methods used in completed model tests will be repeated. However, new discharge points will be employed at station 0+00 with Trenton discharges of 3,400; 7,000 and 12,000 cfs.

b. Transit-time measurements will be continued until mass movements have reached station +130, or until the 3,400 cfs test "blends" with previous transit-time curves of similar flow stage. If 7,000 and 12,000 cfs tests result in values logically dispersed between the completed test series 5,000 and 16,475 cfs, including the Schuylkill already completed, these tests may be terminated when mass movement finds show such conditions.

C. Mixing or Dispersion Characteristics

1. Determine whether a mixing-constant relationship $(X - L (1-Ce^{-kt})$ exists from station to station in the river and whether "intermediate" constants can be interpolated justifiably from this relationship for other stations. Consequently, the maximum build-up of inert constituents under continuous waste discharge conditions during high water slack and low water slack will be established. Since deoxygenation constants for organic matter have not as yet been established for various portions of the river, tests should continue for 180 cycles unless the maximum build-up plateau has been reached prior thereto.

2. Since a relationship may be evident from selected tests to warrant interpolation for intermediate values, the following reduced initial action will be undertaken:

a. Perform a complete series of dye discharges; one in each of the five established sections, at the same Trenton flow of 3,400 cfs, or a total of five tests.

b. In the critical pollution area, Navy Yard - Paulsboro, perform the test at station +50 with additional Trenton flows of 5,000; 6,000; 7,000 and 8,000 cfs or an additional four tests.

c. This constitutes a total of nine (9) tests for this phase in lieu of the potential 25 tests.

In summation, a total of 12 tests, initially, should be performed to cover the transit-time and build-up phases.

VI. Results of the Project

A. The results of this Project will be tabulated by the personnel designated by the Technical Committee, and transmitted to the members of this Committee as soon as possible.

B. These data shall be the property of the Sponsors and shall be released as a joint report for general distribution by the Technical Committee only with the concurrence of all of the Sponsors.

C. All interpretation of these data shall be subject to review by the Technical Committee and shall be released as joint report only with the approval of all of the Sponsors.

D. In the event that the Sponsors are unable to agree on the release of a joint interpretive report, within thirty (30) days after receiving such report, each Sponsor shall be free to release his own interpretive report provided that copies are furnished to each member agency of the Technical Committee, thirty (30) days prior to the release date and provided further that all such interpretive reports shall include a statement by the Sponsor preparing such report of the approval or disapproval of each of the Sponsors.

VII. Progress Reports

The Technical Committee shall furnish progress reports as appropriate to each of the Sponsors. Such reports shall include a copy of a summary of the minutes of each preceding Technical Committee meeting.

VIII. Fiscal Procedures

Incodel will act as the fiscal agent for the parties to this Agreement and will maintain a current separate account showing the income and expenditures for the study. This account will be subject to audit by each of the parties to this Agreement or their agents. Incodel agrees to submit whatever reports are required by State laws and regulations to each of the parties of this Agreement.

JAMES H. ALLEN	Interstate Commission on the Delaware River Basin (Incodel)
C. L. WILBUR, JR., M.D.	Pennsylvania Department of Health
DANIEL BERGSMAN, M.D.	New Jersey Department of Health
A. JOEL KAPLOVSKY	Delaware Water Pollution Commission

CHAPTER IV

SUMMARY OF REPORT

INCODEL chaired a committee of representatives from the States of New Jersey, Delaware, the Commonwealth of Pennsylvania, and the USPHS, which compiled and evaluated a series of experiments performed on the Delaware River Model located at the Waterways Experiment Station in Vicksburg, Mississippi. This series of experiments was specifically designed to supplement existing studies performed by the Corps of Engineers and other private interests with regard to dispersion and distribution of contaminants in the Delaware River Estuary. A total of fourteen experiments was conducted; nine of which were performed under continuous discharge conditions, and five under instantaneous release procedures. Results and data were compilated and numerous calculations were made to establish, based upon the findings, the transit time within the Delaware River and the ultimate buildup levels of conservative material which result at different locations of the river during various conditions of flow. An Analog Computer was programed to fit specific formulae corresponding to the data collected. A sample calculation, based upon the findings, presents a comparison of a theoretically loaded stream with the prototype findings.

For the purpose of clarity, due to the size of this report, the dispersion aspects were set forth in Part I and the application of these findings toward establishing self-purification capacity is presented in Part II.

CHAPTER V

SUMMARY OBSERVATIONS AND CONCLUSIONS

For the purpose of expedience the various observations and conclusions are segregated as to correspond to Part I and II of this report.

PART I

DELAWARE RIVER ESTUARY MODEL STUDY

1. The continuous discharge of a conservative material (dye) into the tidal estuary will induce a buildup of material downstream and upstream from the point of discharge (steady-state flow) until a point of equilibrium is reached.

2. The nature and rate of buildup is well defined by the unimolecular equation $X = L\ (1 - C \times 10^{-kt})$.

3. The equation can be programed in an Analog Computer and the rate coefficients determined for the data accumulated from the continuous discharge tests.

4. The magnitude of the equilibrium buildup level (L) resulting from a specific point of discharge will attain progressively lower plateaus of equilibrium, downstream and upstream, from the point of discharge (steady-state flow.)

5. The maximum equilibrium level achieved from a given discharge will be located downstream from the discharge point at a distance dependent upon the flow stage.

6. The ultimate buildup levels will decrease uniformly downstream from the point of discharge with increasing flow levels.

7. A plot on semi-log paper of the rate coefficients from a given point of discharge will result in a straight line relationship downstream. Increasing flow will result in progressively higher rate coefficients values at any specific location.

8. Rate coefficients derived from the unimolecular equations at progressive locations downstream from a point of discharge will show progressively decreasing values.

9. It follows that the rate coefficients corresponding to various periods of buildup at different stages of flow will form a series of parallel lines when plotted against progressive locations downstream from the point of discharge on semilog

paper.

10. The parallelism relationship of rate coefficients between progressive locations and during variable flow stages indicates the feasibility of interpolating rate coefficients for areas lying between two known values.

11. Similarly, ultimate buildup values showed a relationship to adjacent positions to warrant interpolation of concentration for intermediate locations.

12. Instantaneous dye release experiments can be used at any controlled flow stage to determine transit time within the entire Delaware River Estuary. The observation made by the Corps of Engineers, (COE) in areas downstream from station 50, in that the river is a continuous system and that the point of discharge has no bearing on the resultant transit time through any given reach, was confirmed in areas upstream to Trenton, New Jersey.

13. Transit time observations of both the COE and the Incodel studies indicate that the Delaware River estuary is a continuous tidal system from the head-waters at Trenton to the Bay and that a split river downstream from Trenton consisting of tidal and straight-run river does not exist.

14. Transit time studies made in areas upstream from Allegheny Avenue blended with the findings of the COE from the areas downstream.

15. Stage of flow has a material effect upon the transit time and at a controlled flow of 3700 cfs, as much as 150 tidal cycles or 75 days are required for the mean movement of material to travel from Trenton, New Jersey to approximately Wilmington, Delaware. As a comparison at mean river flow of 12,350 cfs, as measured at Trenton, this same distance is traversed in 55 tidal cycles, or approximately 27 days.

16. A dye loss correction factor is of great significance in the continuous type release experiments. In the instantaneous release test the dye loss correction has little or no significance since the center of mass movement is basically the same, irrespective of the dye loss.

17. The loss of dye is affected by the time of exposure, the concentration of the dye, the wetted perimeter and whether a portion of the dye has reached areas where measurements are not normally made, such as the Delaware Bay.

18. After the various dye corrections were applied, a re-evaluation of data indicated quite clearly that the parallelism-relationship for ultimate buildup and rate coefficients values were still valid.

PART II

POTENTIAL APPLICATIONS OF MODEL STUDY FINDINGS TOWARD PURIFICATION CAPACITY EVALUATIONS

1. If the rate coefficients resulting from a steady state flow condition are plotted on quadrangle paper as to location downstream and upstream from the point of discharge, a typical Gompertz curve results.

2. The Analog computer can be programed to the formula for this Gompertz curve and coefficients derived therefrom.

3. When the ultimate buildup values resulting from a steady state flow condition are plotted against locations downstream and upstream from the point of discharge, a curve results which appears similar to the Gompertz curve. However, this buildup curve is not a typical Gompertz curve and cannot be programed in the computer in the same manner as was performed with the rate coefficients.

4. Increasing flow will result in lower buildup levels and a decrease in transit time between any two given locations.

5. At various conditions of theoretical temperature and rates of stabilization, it has been shown that the effect of increasing flow is not the same in all locations.

6. The lower buildup levels with increasing flow would correspond to decreased pollution concentrations of waste material. However, the decreased time of transit as induced by increased flow will result in less stabilization of decomposable material between any two given locations. The net result of these two opposing effects determine whether increased flow is beneficial or detrimental within any given area.

7. In general, increased flow is usually beneficial under most conditions in upstream areas and non-beneficial in the lower reach of the Delaware River, the transition zone being between Paulsboro and Marcus Hook.

8. It has been shown that in areas of transition, during periods of low temperature or low

stabilization rates, which are normally attributed to winter conditions, increased flow will result in beneficial effects under all stages of flow. However, in the same location, during higher temperatures and higher rates of stabilization, which correspond to a summer season, increasing flow will result in poorer water quality.

9. The three primary oxygen sources are from reaeration, dilution water and photosynthesis. The amount of oxygen supplied to the Delaware River through reaeration at conditions of equilibrium indicates that the estimated pollutional loading inventory for the Delaware River Basin of 770,000 lbs of 5-day B.O.D. per day (as of 1958) is too low.

10. It follows that a re-evaluation of the pollution loading inventory be completed as soon as possible and ultimate oxygen demand measurements be conducted on each of the major waste sources.

11. Combining the transit time findings with the stabilization rates derived from the prototype studies and employing a geometric progression buildup, coupled with pollution loadings equivalent to the oxygen supplied to the river through reaeration alone, river B.O.D. values similar to those observed during prototype investigations resulted.

12. Photosynthetic activity within the upper Delaware River estuary is significantly less, as compared to the findings in the Patapsco (Baltimore) and Potomac (Washington, D.C.) Rivers.

PART I

DELAWARE RIVER ESTUARY MODEL STUDY

CHAPTER VI

LITERATURE SURVEY

The tidal prism theory has been used by investigators to explain flushing characteristics in estuaries for many years. A tidal prism is equal to the difference between the volumes of water in a section at high and low tides. In applying the tidal prism theory, the volume of water entering the estuary from the ocean is presumed to be available for dilution and removal of pollution during each tidal cycle. This theory is based on the two following assumptions:

1. The water entering the flood tide mixes completely and uniformally with the water present in the estuary at low tides.
2. The volume of water moving seaward on the ebb tide escapes and is not returned to the area on the next tide.

   These assumptions have been found to be incorrect by various investigators under actual conditions. Ketchum (19) reported that the tidal prism theory does not well describe the flushing of estuaries.

Ketchum has modified this procedure somewhat to produce results which agree more closely with observed conditions in a variety of estuaries. In his modification the volume of water available for dilution is that which escapes on the ebb tide through various cross-sections and does not return on the succeeding flood tides. "If it is assumed that the water present in each of the volume segments is completely mixed at high tide, the proportion of water removed by the ebbing tide is given by the ratio between the local inter-tidal volume (the difference between high and low tidal volumes within an area defined by the limits to which a particle travels during a tidal cycle) and the local high tide volume." This is defined as an "exchange ratio". The volume of water moving seaward is the product of the "exchange ratio" and the accumulated volume of river water. The mixture at any segment is the result of a series of "exchanges".

Ketchum has applied his calculations to three estuaries. (Raritan River and Bay, New Jersey; Alberni Inlet, B.C.; and Great Pond, near Falmouth, Mass.) It was necessary to correct two of the three for incomplete vertical mixing.

Stommel (25) attempted to apply Ketchum's "Exchange Ratio" method, using the published data (2) on the Severn estuary. This method gave them "a grossly incorrect salinity distribution." The Severn was known to be unstratified and appeared to fit all the requirements of Ketchum's analysis. They concluded that "the method of the exchange ratio is not nearly so general as was proposed."

Stommel found similar objections to the method of Arons and Stommel (1). These methods had been based on "a priori" suppositions about the turbulent mixing process. Stommel (25) feels that the proper procedure is "to use the distribution of river water as a means of discovering the magnitude of turbulent diffusion coefficients at various places in the estuary, and to devise a method using these coefficients which will yield the dilution of pollution at any point in the estuary." He has described one such method (25), emphasizing that it is intended to apply only to vertically unstratified estuaries in which the mixing is due to tides.

Through any cross-section, the net flux toward the sea is equal to the advection due to the fresh water discharge, minus the flux due to tidally produced turbulence. This latter flux is explained mathematically with the aid of a "turbulent eddy diffusitivity." The eddy diffusitivity is computed using known concentrations of any conservative property in the estuary. Stommel has chosen to use the concentration of fresh water since it is a convenient conservative property.

In a numerical example, Stommel applies his theory to the distribution of a non-conservative pollutant. This requires a relaxation method of solution to which his theory is readily adaptable. His "example" is theoretical. This makes an evaluation of results difficult.

Preddy (22) suggests a method of calculating the degree of mixing in an estuary based on observations of fresh water inflows, tidal action, and resulting salinities. He uses the Thames estuary for a numerical example. A distribution pattern is assumed. Then a relaxation procedure is employed to "balance" the assumed distribution.

Changes in salinity predicted from Preddy's results, were found to agree with prototype observations. Preddy also observed good distribution patterns for dissolved chemicals in the estuary. When applying his theory to pollution problems, the initial distribution can be roughly calculated. However, in an estuary such as the Thames, where there are many sources of pollution, his method is very tedious. He feels that methods of solution "can be developed which would simplify the arithmetical work involved".

Preddy (22) modifies his procedure slightly to eliminate time-consuming calculations made necessary by this application. He makes an assumption as to the final distribution (from a single discharge) and carries out one cycle of operations; and then from the discrepancies between the assumed curve and the calculated distribution after mixing, he makes another estimate of the final distribution. This procedure is repeated until the difference between the assumed and calculated curves is negligible.

Preddy and Gameson (13) apply Preddy's mixing theory to the distribution of Ultimate Oxygen Demand and Biochemical Oxygen Demand in the Thames estuary. Their method is to calculate separately the effects of principal discharges, and then to add them together to obtain the combined effect. This is dependent upon the validity of four provisions:

1. The rate of solution of atmospheric oxygen is proportional to the oxygen deficiency;
2. The total effect does not make the water anaerobic at any point;
3. The presence of one discharge does not affect the rate of oxidation of another;
4. The volume of flow of any discharge is not sufficient to alter the distribution of another.

In this application to non-conservative pollutants, Preddy and Gameson suggest a procedure of "addition, decay, displacement, and mixing," to be repeated until equilibrium is attained. A comparison has been made between observed data and calculated curves. Agreement between the two is "as close as can be expected from the nature of the calculations." Calculated curves are for equilibrium conditions of flow and temperature. The observed data are not.

The Corps of Engineers Delaware River Model Study Report #2 (8) contains pertinent information of water movement in the Delaware River and facts which may prove of value in studying the prototype. It is reported that prototype water samples collected within 12 minutes of high or low water slack are considered quite valid for model study work. Another point of interest is that an ebb or a flood tide may travel as much as 45,000 feet per tide. Specific reference is made to the proposed Incodel Plan and how implementation of this plan would effect the movement of the 50 p.p.m. isochlor within the Delaware River. The report (8) concluded that the Incodel Plan would not prevent the 50 isochlor from moving upstream from Penna.-Del. State line.

A further point of interest brought out in this model study is that mixing of shoreline discharges with ship-channel waters, takes place rapidly except where certain natural or man-made abutments and/or obstructions exist. Once the shore discharges have reached the channel area, they mix completely with the channel waters.

Tests were made by the Chesapeake Bay Institute to study movement of pollution in the Delaware model. Results are presented in a report by Pritchard (23). His main discussion centers on the variation in concentration along the axis of the estuary.

In his presentation, Pritchard used "corrected" data. His correction factor is simply a ratio of the total weight of dye added to the total weight of dye found in the model at any time.

Pritchard observed that "at prominent bends in the river, the advanced portion of the contaminated volume would cling closer to that shore having a more rapid downstream movement of water." Conversely, channel areas having the greatest velocity of flow should carry a greater portion of the contaminated shoreline discharges. Downstream movement of peak concentrations is significantly slower than the calculated velocity of the mean downstream water movement. Tests were conducted to determine how a change in tidal amplitude would effect the time change in contaminant concentration. However, the results did not provide conclusive information.

Since Pritchard's objective was to study dye movement in the estuary, his experiments employed an instantaneous release of dye. The dye was released at high water slack from a cylinder constructed so that the sides could be freed from the bottom and pulled out of the water. This left the dye suspended momentarily in the water in a cylindrical shape. As the ebb tidal movement started, the dye spread rapidly in both a lateral and longitudinal direction. He found the rate of decrease in concentration during the first two tidal cycles to be extremely rapid when compared to the "decay" rate following the second tidal cycle. In more recent experiments (29), a modification of the instantaneous release procedure has been made. The dye is now mixed between two templates placed across the estuary. These templates are drawn out at high water slack as before. Now as the ebb tidal movement starts, only longitudinal mixing occurs.

Pritchard's data indicates a discontinuity in the Delaware. At a controlled flow of 12,350 cfs, dye released at Station 52.5 (approximately Fort Mifflin) required 17 cycles or 8.5 days to travel from Cherry Island to New Castle. In a second experiment, at the same flow, dye released at Station 111 (Chester) required only 8.8 cycles or 4.4 days to travel the same distance.

The Corps of Engineers performed tests (unpublished data) similar to Pritchard's. Their results support the belief that the Delaware River and Estuary is a continuous system. The Waterways Experiment Station, states that, "the results of these tests indicate that location of the contaminated area has little effect on dilution and flushing characteristics." They also indicate, "that river discharges do not change appreciably the rate of decay of the peak concentration with time, which suggests that dilution of the contaminant is largely a function of the tidal forces." In general, the Corps has improved upon Pritchard's experiments through additional experiments of their own.

The duPont Company ran a series of eighteen experiments (6) in an attempt to achieve a better diffusion of their waste effluent discharge from the Deepwater Point and Carney's Point Plants. They found that good dispersion would result by discharging continuously through a pipe line extended into the Delaware River. Their existing system consisted of discharging from retention basins through tide controlled sluice gates. Not only did they find that lower concentrations would result from the pipeline discharge, but they also were able to determine the optimum pipeline length.

In the duPont experiments, dye was released continuously through a simulated pipeline extending varying distances into the river. They were interested in concentration buildups near the shores, so few samples were taken at the channel centerline. Their experiments lasted an average of forty-five cycles.

In the duPont report, dye concentrations are expressed in parts per million (ppm). An analogy to the prototype is more readily made when dye concentrations in the model are expressed as a percentage of the effluent concentration.

A study of the data, which was made after the publication of the duPont report, led Dr. Falk to the finding that the dye concentration buildup curves can be fitted to a unimolecular equation. This analogy has been applied to the data in this report (Chapter X).

About two months after the duPont experiments, the New Jersey Zinc Company (5) used the Delaware River Model to study plans for improving the dispersion of effluent in the Delaware River from their Gloucester City Plant. They were particularly concerned in determining the extent to which their waste discharge moved upstream. They also wanted to determine whether the high waste concentration which was building up in small embayments and pockets along the New Jersey shore in the vicinity of the plant could be eliminated. Among the general conclusions drawn from their tests are:

1. "River discharge appears to be the dominant factor controlling effluent concentration and extent of upstream intrusion."

2. "An increase in plant effluent discharge from 6 to 12 mgd would essentially double effluent concentrations at equivalent locations along the river, all other conditions being equal, but the increased effluent discharge would not cause a significant increase in the extent of upstream intrusion of the effluent."

The Zinc Company has made a good collection of data, in that, a large number of samples have been collected at each sampling station. However, there were very few sampling stations in the channel. At high water slack, samples were collected at six channel stations, while at low water slack, only one station was sampled. In the report, concentration is expressed as a percentage of the effluent concentration. This is essential since they have allowed the concentration of the effluent to vary from test to test. The nine experiments covered flows of 2,400; 3,400; 8,000; and 12,000 cfs. Since the volume of effluent discharge, the discharge station, and the method of discharge all vary, it is difficult to make comparisons between tests.

Concentration distribution patterns resulting from the experiments are of the same type as those obtained from Incodel experiments presented in this report, although, the duration of some of the Zinc Company's experiments was not sufficient to obtain ultimate concentration values.

A recent (April, 1959) report by the Corps of Engineers entitled, "Contamination Dispersion in Estuaries" (4), describes model studies of the Delaware River. Release procedures simulated a spill resulting from an accident to a nuclear powered ship, and were neither instantaneous nor continuous for the duration of any experiment. The fresh water discharge in the experiments is unusual, in that it was controlled to conform to the hydrograph, at, and including, the Schuylkill River, for September - November, 1931. Such a procedure allows a comparison to be made between actual flow conditions and the normal test procedure of a sustained flow condition. The effect of a more variable hydrograph would have been of considerable interest, however, the flows in the chosen period vary from three to four thousand cubic feet per second and exceed this range only for a very short period of time.

Their treatment of dye loss is of interest. They found (4) that the dye (Methylene Blue Chloride) used as a tracer was only 90 percent of the manufacturers stated strength. To utilize their concentration readings, which are expressed as a percentage of the initial concentration, their readings were multiplied by a factor of 1.11.

This report (4) also presents correction factors for dye loss due to absorption and adsorption. These factors are the result of a special test devised for that purpose. They have not corrected the data in this report because "previous experiments have shown that this loss does not appreciably effect computations of rates of movement of the tracer". The fact that they have recognized the need of a dye loss correction, for the first time in this report, is of importance. The method of expressing the correction factors needs further clarification. If after 160 cycles, 45.9 percent of the dye is lost, the factor to be applied to the concentration after 160 cycles is $\frac{100}{100-45.9}$ or 1.85 and not 1.46 as reported.

The Corps of Engineers Report #2 (8) also concluded from its model studies that to hold a 100 ppm isochlor at the Delaware-Pennsylvania State Line would require a sustained fresh water discharge of 10,500 cfs., including the Schuylkill River. To maintain a 10,600 cfs., discharge would be an extremely costly proposition. This is a most interesting point since the Incodel Plan proposed 4,800 cfs., at Trenton. The importance of fresh water diversion out of the river basin upon the river conditions is stressed.

The Corps of Engineers Report #3 (7) concluded from model studies that the proposed enlarged channel from Philadelphia to Trenton would not increase salinity concentrations in any portion of the estuary during either normal or very low fresh water discharges.

The effect of cooling water discharged by the Tidewater Refinery was considered in the Corps of Engineers miscellaneous paper number 2-125 (9). Model studies indicate that this discharge would not significantly affect temperatures in the river at intake locations.

Kaplovsky (14) has presented a "same-slack" technique of sampling to determine river quality. This technique minimizes the overall effect of tidal movement, flow, and weather conditions on the findings by sampling the entire estuary in one day at the same tidal stage. This procedure is identical to the model study practice of taking all samples during high or low water slack. The validity of this technique in the prototype is illustrated by a comparison of "same-slack" values to cross-section series findings measured under similar conditions.

Further comparison between the two sampling procedures is given in another report by Kaplovsky (15) on water quality in the lower Delaware River.

Haseltine (28), a witness for the Commonwealth of Pennsylvania in the Delaware River Diversion Case, 1952-1954, testified on several aspects of water and waste problems, among which specific reference was made to the effect of low flow augmentation upon sanitary and chemical quality of the Delaware River. With respect to the sanitary quality, the testimony presented by Haseltine was extremely interesting, in that, it was not only informative, but raised many new problems for which adequate scientific information is not available. A conclusion pertinent to this report was: "Augmentation of river flow affects sanitary conditions in two ways. First, it affords additional dilution at the points of entrance of sewage or wastes, thereby reducing the concentration of pollutants at that point, even though it does not reduce the actual pollution load on the river. Secondly, it results in higher river velocities and so decreases time of transit between the point of entrance of such wastes and any downstream point of water usage. Time is essential if full advantage is to be taken of the self-purification capacity of the stream. Thus, although the dilution resulting from flow augmentation is beneficial, the resulting decrease in time available for natural purification is deleterious. The resultant effect on stream sanitation may be either helpful or harmful in any particular case. It will not be the same in all sections of the river."

Another conclusion made by Haseltine (28) was: "Between Torresdale and Marcus Hook the estuary is so broad and deep that under all but the highest flows the retention time in that zone is sufficient to utilize most of the stream self-purification capacity. The principal source of oxygen in this zone is that absorbed from the atmosphere over its broad surface. The D.O. contributed by the river inflow from above is very small in comparison with that obtained from surface reaeration. Because of these two facts, variations in fresh water inflow to this zone have relatively little effect upon its capacity to assimilate pollution."

A very significant statement made by Haseltine is: "During periods of high stream flow, scouring velocities may prevail so that sludge deposits are picked up, moved downstream and redistributed over a different and greater bottom area. In general, the effect of flood flows is beneficial since it tends to equalize the pollution burden over a considerable stretch of river instead of permitting heavy loads to localize at or near sewer outlets."

A summary statement by Haseltine (28), as follows, was of particular interest: "Bacterial pollution at Trenton is 2 to 3 times as great at flows of 4,000 to 5,000 cfs. as it is at flows of about 2,000 cfs. The bacterial pollution at Trenton continues to rise with increased flow throughout the range of flows. Not until the flow exceeds 10,000 cfs. does the concentration of coliform organisms become less than at flows below 2,000 cfs." In Zone III, as established by Incodel, both procedures (rational and U.S.P.H.S.) indicate that under "future conditions" a Trenton discharge of at least 9,000 cfs. would be required to maintain an oxygen saturation of 50 percent during the summer months. They also agree in indicating that the maintenance of Trenton flows at 4,000 to 4,800, cfs. would not result in any material improvement of sanitary conditions in that zone.

Haseltine (28) made some profound statements as follows: "No practical amount of low flow augmentation would justify any reduction in degree of treatment proposed for sewage and industrial waste prior to their discharge to the Delaware River. An appreciable portion of the present burden on the self-purification capacity of this lower zone is due to the oxygen demand of the sludge deposits that have accumulated in that zone over the past years when most sewage and wastes received little or no treatment. The presently proposed degree of treatment for sewage and wastes tributary to this zone will materially reduce, but not wholly eliminate, those sludge deposits. Therefore, they will continue to exert a pronounced, though diminished, demand on its oxygen resource."

CHAPTER VII

DESCRIPTION OF THE MODEL (8)

The Delaware River Model reproduces the entire estuary of Delaware Bay and River, beginning at Capes May and Henlopen, at the downstream end, and extending to Trenton, New Jersey, at the upstream end. The tidal portions of all major tributary streams (Maurice, Cohansey, Salem, Christina, Schuylkill, and Rancocas Rivers) are reproduced to correct lengths and cross-sections, but portions of the tributaries are realigned to conform to the general alignment of the main stream. A 3-mile reach of the Chesapeake and Delaware Canal, beginning at its junction with the Delaware River, is also reproduced.

The model is constructed to linear scale ratios, model to prototype of 1:1000 horizontally and 1:100 vertically. These scale ratios fix the following relationships: slope, 10:1; velocity, 1:10; time, 1:100; discharge, 1:1,000,000; and volume 1:100,000,000. The salinity scale ratio required for an investigation of this type is 1:1. One prototype tidal cycle of 12 hours and 25 minutes is reproduced in the model in 7.45 minutes. The model is about 750 ft. long, about 130 ft. wide, at the widest point, and covers an area of about 30,000 sq. ft.

The model is equipped with the necessary appurtenances to reproduce and measure all pertinent phenomena. These appurtenances include primary and secondary tide-control mechanisms, tide recorders, fresh water inflow measuring devices, current meters, and tide gages.

Measurements of tidal elevations in the model are accurate to within plus or minus 0.1 ft. prototype (0.001 ft. model). Since the maximum error between model and prototype tidal data was of approximately this same order of magnitude, the model tidal adjustment was considered satisfactory.

With meter measurement limitations in mind, it is believed that current velocity measurements in the model are accurate within plus or minus 0.5 ft. per sec. prototype (0.05 ft. per sec. in the Model). Figure VII-1

The accuracy with which the results of Model salinity tests could be duplicated, for identical conditions of tide, fresh-water discharge, etc., is believed to be of the order of 5 percent.

The rise and fall of the tide in the Model, and the resulting flood and ebb tide currents, are reproduced by pumping water into the Model at the ocean end to reproduce the flooding tide and removing it by gravity to reproduce the ebbing tide. Electrically controlled automatic valves are installed in the pumped inflow and gravity outflow lines, and their operation is regulated by a system of cams and relays so that tidal elevations and times at the primary tide control station (Miah Maull Shoal Light) are reproduced accurately.

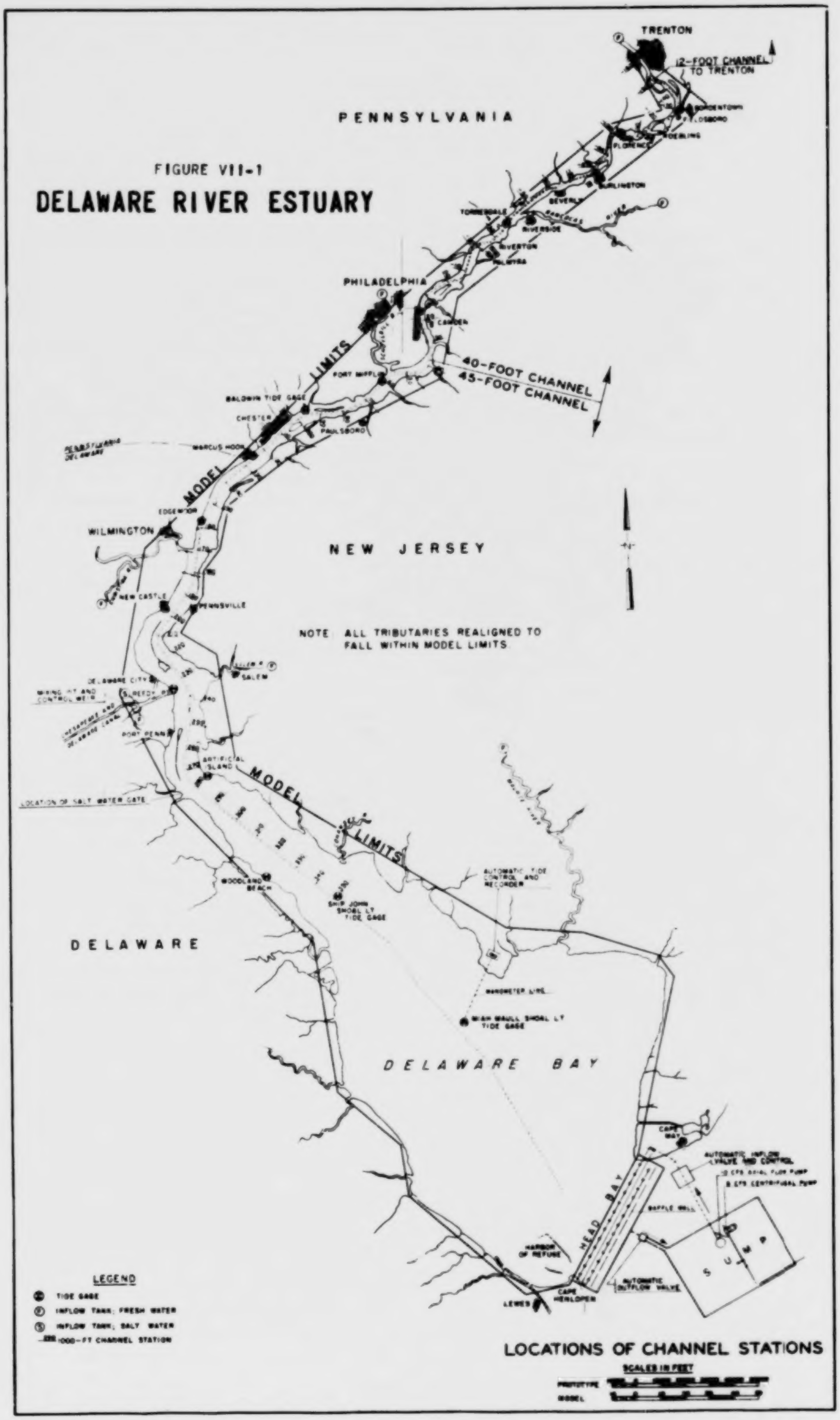


FIGURE VII-1

DELAWARE RIVER ESTUARY

LOCATIONS OF CHANNEL STATIONS

PENNSYLVANIA
TRENTON
12-FOOT CHANNEL TO TRENTON
BORDENTOWN
FIELDSBORO
ROEBLING
FLORENCE
BURLINGTON
BEVERLY
TORRESDALE
RIVERSIDE
RIVERTON
PALMYRA
PHILADELPHIA
CAMDEN
MODEL LIMITS
FORT MIFFLIN
40-FOOT CHANNEL
45-FOOT CHANNEL
BALDWIN TIDE GAGE
CHESTER
PAULSBORO
PENNSYLVANIA
DELAWARE
MARCUS HOOK
EDGEMOOR
WILMINGTON
NEW JERSEY
N
NEW CASTLE
PENNSVILLE
NOTE: ALL TRIBUTARIES REALIGNED TO FALL WITHIN MODEL LIMITS.
DELAWARE CITY
SALEM
MIXING PIT AND CONTROL WEIR
READY PT.
CHESAPEAKE AND DELAWARE CANAL
PORT PENN
ARTIFICIAL ISLAND
MODEL LIMITS
LOCATION OF SALT WATER GATE
AUTOMATIC TIDE CONTROL AND RECORDER
WOODLAND BEACH
SHIP JOHN SHOAL LT TIDE GAGE
DELAWARE
MANOMETER LINE
BRANDYWINE SHOAL LT TIDE GAGE
DELAWARE BAY
CAPE MAY
AUTOMATIC INFLOW VALVE AND CONTROL
10 CFS AXIAL FLOW PUMP
5 CFS CENTRIFUGAL PUMP
BAFFLE WALL
HEAD BAY
SUMP
HARBOR OF REFUGE
AUTOMATIC OUTFLOW VALVE
CAPE HENLOPEN
LEWES
LEGEND
TIDE GAGE
INFLOW TANK; FRESH WATER
INFLOW TANK; SALT WATER
1000-FT CHANNEL STATION
SCALES IN FEET
PROTOTYPE
MODEL

CHAPTER VIII

MODEL TEST PROCEDURE

A series of tests was devised which would give the desired information, as set forth in the Agreement (see Chapter III), and still keep the number of tests to a minimum.

The possibility that a relationship with regard to ultimate buildup levels and buildup rates from location to location would be evident from selected tests to warrant interpolation for intermediate values, the following experiments were performed:

1. Dye discharges were made in each of five established sections, at the same Trenton flow of 3,400 cfs (Incodel tests 1,2,3,4, and 5). The point of discharge was selected from a plot of the nitrogen content (17) in the river which had indicated five distinct plateaus. These nitrogen levels were established from "slack water sampling" data on the prototype between Reedy Island, Delaware to Trenton, New Jersey. The mid-points (stations -100; +00; +50; +130 and +170) of the five plateau regions were used as the release points for the five tests.

In an effort to expand the above continuous type discharge series, additional tests were performed at station +50 during Trenton flows of 4,500 cfs; 5,500 cfs; 7,000 cfs and 8,000 cfs (noted as Incodel tests 7,6,8, and 9 respectively).

These nine continuous type tests were conducted for a period of 180 cycles to well establish the maximum buildup plateau. Test 4 was the only experiment which was run for a shorter duration. In the latter instance the model operation was stopped during cycle 140 due to a failure of the inflow valve motor.

The conservative indicator in the model was simulated by the Blue dye (duPont Methylene Blue ZX). The dye was added to the model at the rate of 100 ml. per tidal cycle. Concentrations of dye being added was reported as 1,000 ppm. It was later found that the actual concentration was 913 ppm (Chapter XIII offers further explanation). This model discharge is equivalent to a conservative waste discharge of 0.45 lbs. per second in the prototype.

2. In view of the extremely important Navy Yard section (station +50) and upstream, pollutionwise, not included in the former test series, plus the unknown validity of transit time interpolation to upstream areas during lower flows, it was decided to perform further transit time studies in the upstream reach above Allegheny Avenue. Consequently, the three tests at different flows were made employing similar dye concentrations and methods of previous model tests. The discharge location was station 0+00 and the three flows were 3,400 cfs; 7,000 cfs, and 12,350 cfs at Trenton (Incodel tests 10, 11, and 12). Float studies were also conducted in the uppermost reach of the estuary at the time tests 10, 11, and 12 were made. The float study results warranted further transit time studies above Allegheny Avenue, namely, Incodel tests 13 and 14.

For the instantaneous discharges (Incodel tests 10, 11, 12, 13, and 14) a larger initial release of dye was made than was done in the continuous type experiments. This was found necessary, based upon experience of the Waterways Experiment Station, to insure measurable concentrations which would remain for the duration of the tests.

Methylene Blue has its maximum absorption at 680 millicrons. The possibility of using two other dyes of different wavelengths was considered. By using three dyes simultaneously, three tests could be performed at once. This would permit a much more complete testing program. The two other dyes considered were duPont Auramine SP and duPont Rhodamine B Extra.

Experiments were performed by the State of Delaware Water Pollution Commission to determine whether the concentration of these three dyes could be determined when mixed together in different proportions. The laboratory experiments were quite promising.

Unfortunately, the natural turbidity of the model water is so variable that adjustments to compensate for the turbidity would not be possible if more than one dye were used and the multiple dye procedure was abandoned.

A summary of test conditions employed is given in Table VIII-1. The float studies in the uppermost reach of the river model were made with a short weighted pencil maintained in upright position which extended the equivalent of approximately 20 feet below the surface.

TABLE VIII - 1

SUMMARY OF DELAWARE RIVER MODEL TEST STUDIES

TEST	Duration of Tidal Cycles*	Channel Station Release Point	Prototype (cfs) Fresh Water Discharge				Date
			Trenton	Rancocas	Schuylkill	Total at Schuylkill	
1	180	-100	3,400	240	900	4,540	2-4-59 2-5-59
2	180	0+00	3,400	240	900	4,540	2-9-59 2-10-59
3	180	50	3,400	240	900	4,540	2-12-59 2-13-59
4	140	130	3,400	240	900	4,540	2-16-59 2-17-59***
5	180	170	3,400	240	900	4,540	2-19-59 2-20-59
6	180	50	5,500	390	1,450	7,340	3-2-59
7	180	50	4,500	320	1,180	6,000	3-9-59 3-10-59
8	180	50	7,000	495	1,840	9,335	3-12-59 3-13-59
9	180	50	8,000	565	2,100	10,665	3-5-59 3-6-59
10	100	0+00	3,400	340	900	4,540	2-27-59
11	70	0+00	7,000	495	1,840	9,335	2-26-59
12	50	0+00	12,350	875	3,250	16,475**	2-25-59
13	55	-155	3,400	240	900	4,540	3-16-59
14	50	-155	5,500	390	1,450	7,340	3-17-59

*Tidal cycle equals 7.45 min. in Model
**Mean flow
***Test 4 discontinued after 140 cycles due to pump breakdown

Tests 1-9 were of the continuous release type, at 100 ml/cycle, with a total volume of 18,000 ml. of dye released. Continuous releases made at mid-depth on Channel center line.
Tests 10-12 were of the instantaneous release type, with a total volume of 2,605 ml. of dye released.
Tests 13-14 were of the instantaneous release type, with a total volume of 1,000 ml. of dye released.
All dye concentrations were 913 ppm.

CHAPTER IX

EXPERIMENTAL RESULTS

This Chapter contains the experimental results obtained on the Vicksburg model. Tables IX-1 thru IX-23 of the Appendix give the dye concentrations (expressed as a percent of the initial concentration) for Tests 1-14. (HWS & LWS) All values in this Chapter are uncorrected for dye loss. The location of these percentages and the effect of varying the number of cycles are also included. As has been explained previously, the Trenton flows and dye release points were the varying conditions distinguishing one test from another. Tables IX-24 - IX-26 of the Appendix, tabulate the net movement of a float between successive high water slack periods using various Trenton flows.

Table IX-27 of the Appendix contains the various dye concentrations, (for Tests 1-9), excluding test 4 at various stations after 180 cycles (HWS & LWS).

CHAPTER X

APPLICATION OF UNIMOLECULAR EQUATION TO EXPERIMENTAL DATA

The experimental results listed in Tables IX-1 through IX-23 of the Appendix have been plotted to show how concentration builds up in an estuary. In this Chapter, we are considering the continuous discharge experiments (Incodel tests 1-9). The instantaneous release experiments are discussed in Chapter XII. A typical "buildup" curve is shown in Figure X-1. These data are very well fitted by the unimolecular equation.

$$X=L(1-Cx10^{-kt})$$

In this unimolecular equation, X is the concentration at any time (t). Concentration is expressed in parts per million (ppm) or percent of initial concentration, and time, in tidal cycles. L is the ultimate dye concentration expressed in ppm or percent of initial concentration. "k" is a velocity coefficient which describes the rate of buildup, and is expressed in cycles $^{-1}$. C is a coefficient from which the lag period between the time of release and the time buildup commences can be calculated where $C=10^{kt_o}$.

To determine the ultimate concentration (L) and the coefficients k, and C mathematically, one can use the Thomas Slope Method (26) of solution. This method provides a "least squares" fit, and involves many time consuming calculations.

The alternate method which was used to determine the coefficients for the majority of the curves was to program an analog computer to plot a unimolecular curve, and then to modify the coefficients to produce a curve of good fit. The final value of the coefficients could be obtained in approximately 5 minutes. Figure X-1 also compares the Thomas Slope Method with the analog solution.

The eye fit procedure was evaluated prior to the Incodel Test series, and therefore, the example (Fig. X-1) using New Jersey Zinc data (5) were included for expediency. Similar results would be evident if Incodel tests were employed.

Tables X-1 through X-9 of the Appendix present the coefficients which produce the curves which best fit the data (by eye), as obtained from the computer.

As indicated above, the unimolecular coefficients will be specific at a given location and flow. However, a comparison of the results from all of the tests will show how the unimolecular coefficients vary with location and flow. First, a composite of "k" versus station number is shown for both of the two series of tests (1, 2, 3, 4, & 5) and (3, 7, 6, 8, & 9). Both high and low water slack results are presented in this manner (see Figs. X-2, X-3, X-4, and X-5). Ultimate buildup (L) versus station number is presented in the same manner in Figures X-6 to X-9.

The change of coefficient "k" and ultimate buildup, L, with flow is shown at 5 stations, (50, 80, 130, 180, and 230) at both high and low water slack. These plots (Figs. X-10 thru X-13) are based on the test series 3, 7, 6, 8, and 9, where the release point is the same for all tests, but the flow varies.

The plots form straight lines on semi-log paper. More interesting is the fact that the families of curves show a parallelism, indicating a definite relationship in the river.

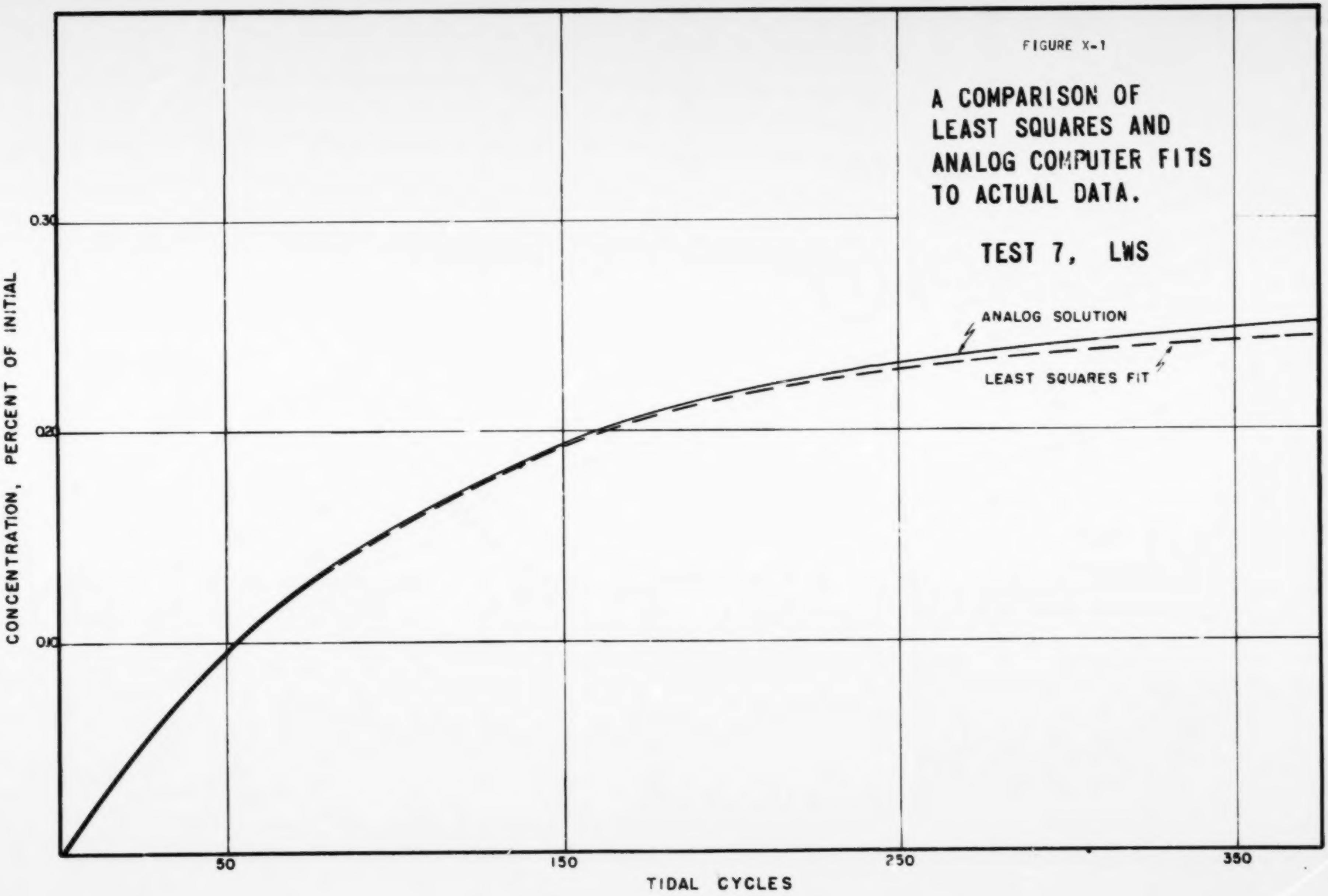


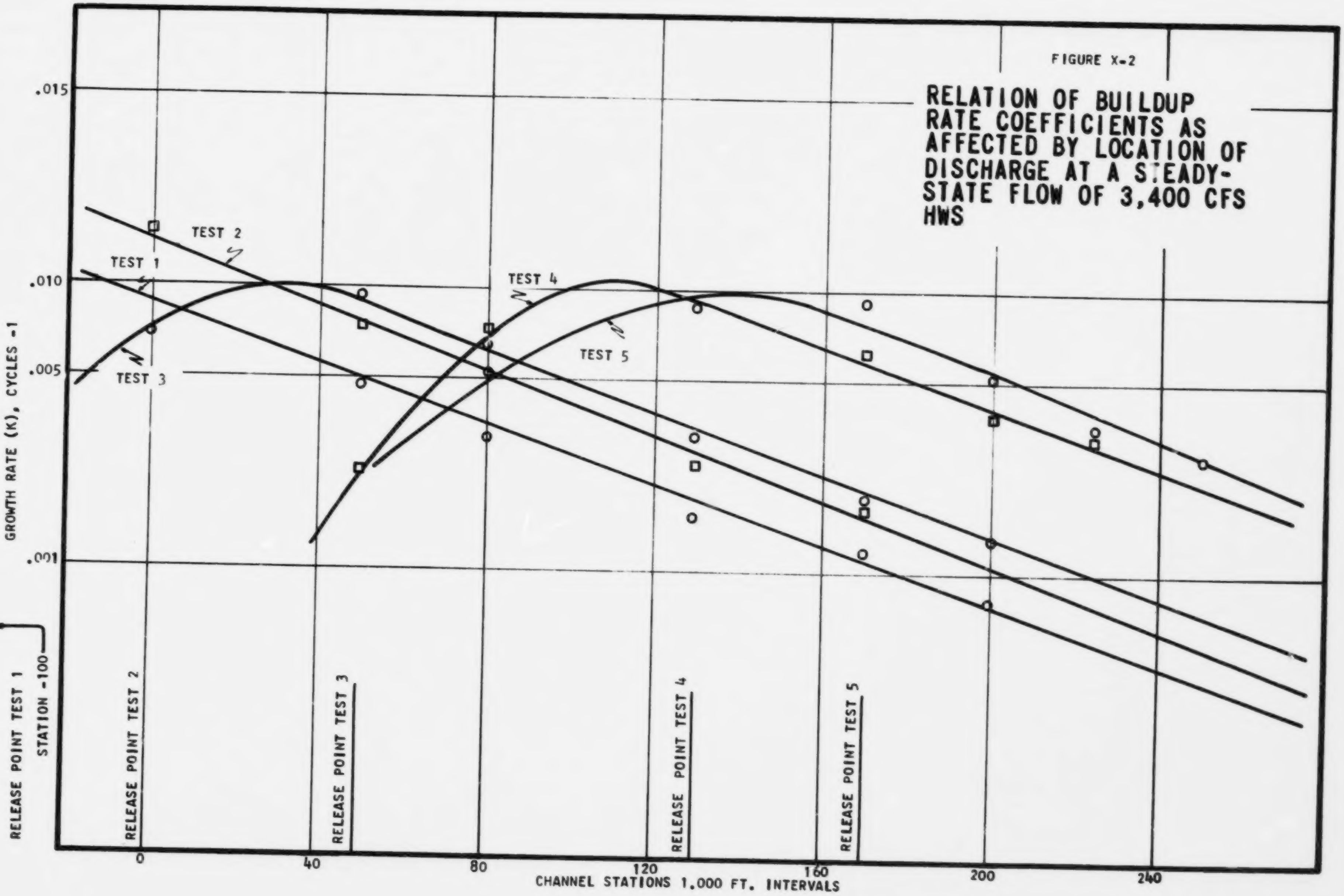
FIGURE X-1

A COMPARISON OF LEAST SQUARES AND ANALOG COMPUTER FITS TO ACTUAL DATA.

TEST 7, LWS

FIGURE X-2

RELATION OF BUILDUP RATE COEFFICIENTS AS AFFECTED BY LOCATION OF DISCHARGE AT A STEADY-STATE FLOW OF 3,400 CFS HWS



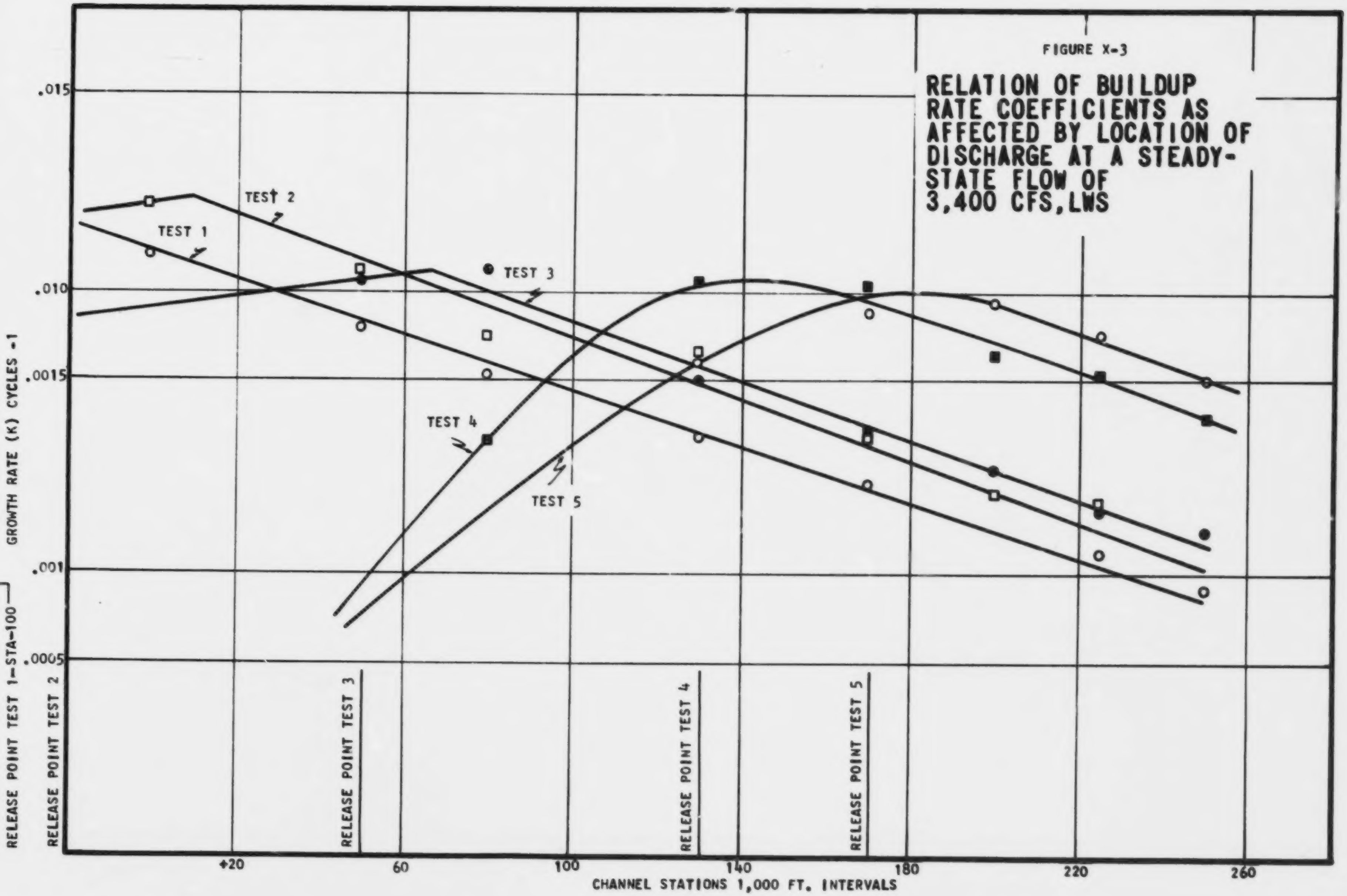


FIGURE X-3

RELATION OF BUILDUP RATE COEFFICIENTS AS AFFECTED BY LOCATION OF DISCHARGE AT A STEADY-STATE FLOW OF 3,400 CFS, LWS

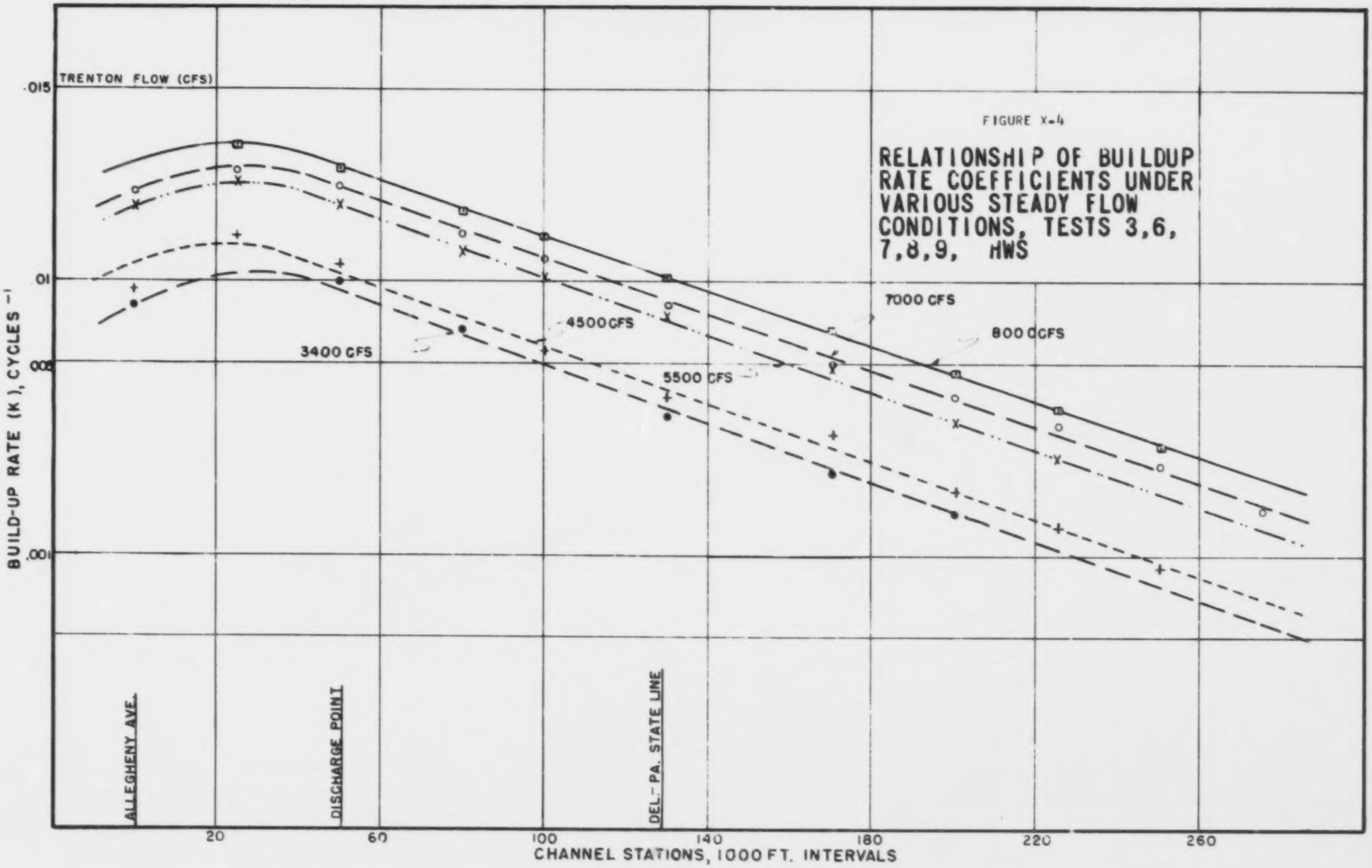


FIGURE X-4

RELATIONSHIP OF BUILDUP RATE COEFFICIENTS UNDER VARIOUS STEADY FLOW CONDITIONS, TESTS 3,6, 7,8,9, HWS

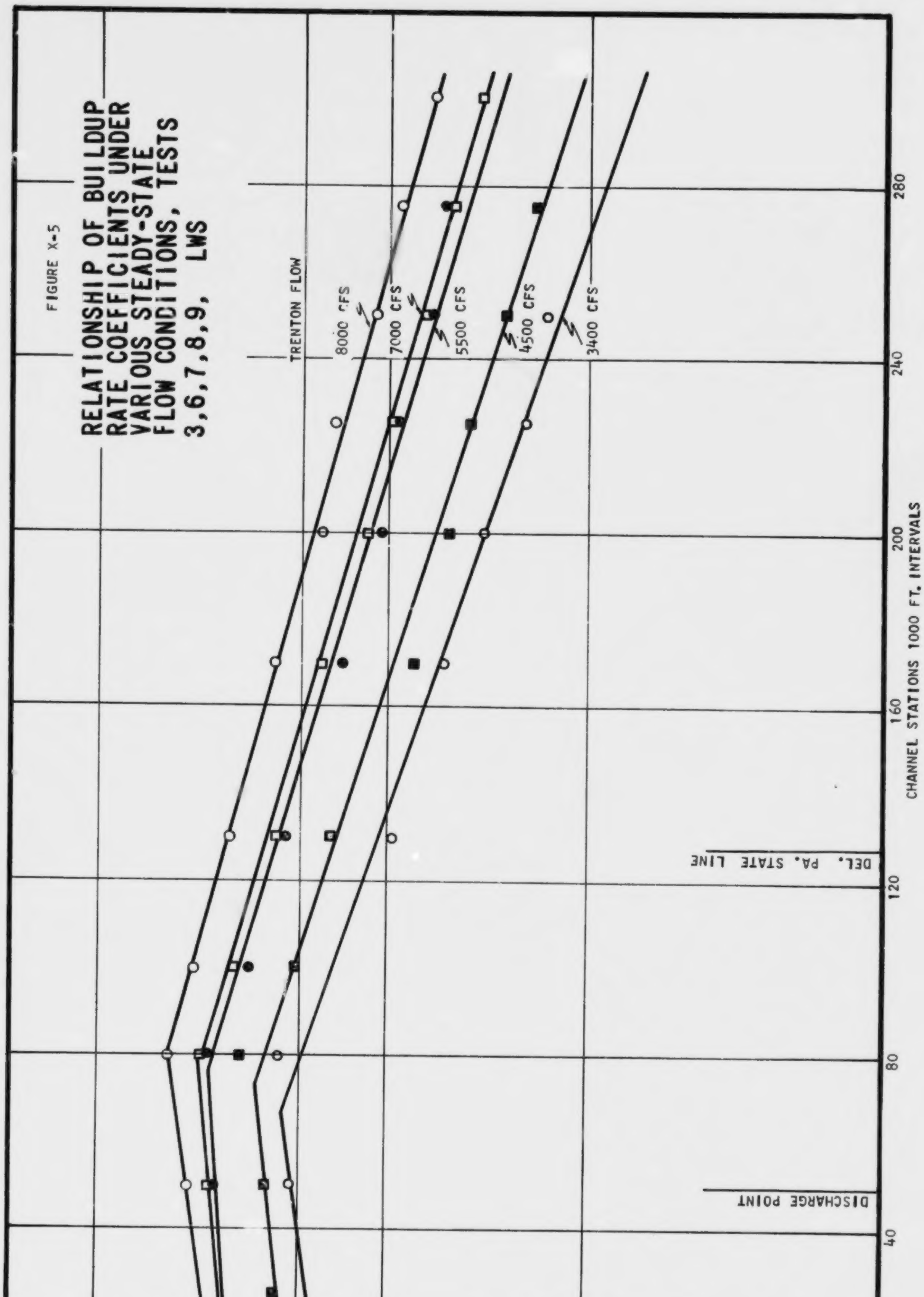


FIGURE X-5

RELATIONSHIP OF BUILDUP RATE COEFFICIENTS UNDER VARIOUS STEADY-STATE FLOW CONDITIONS, TESTS 3,6,7,8,9, LWS

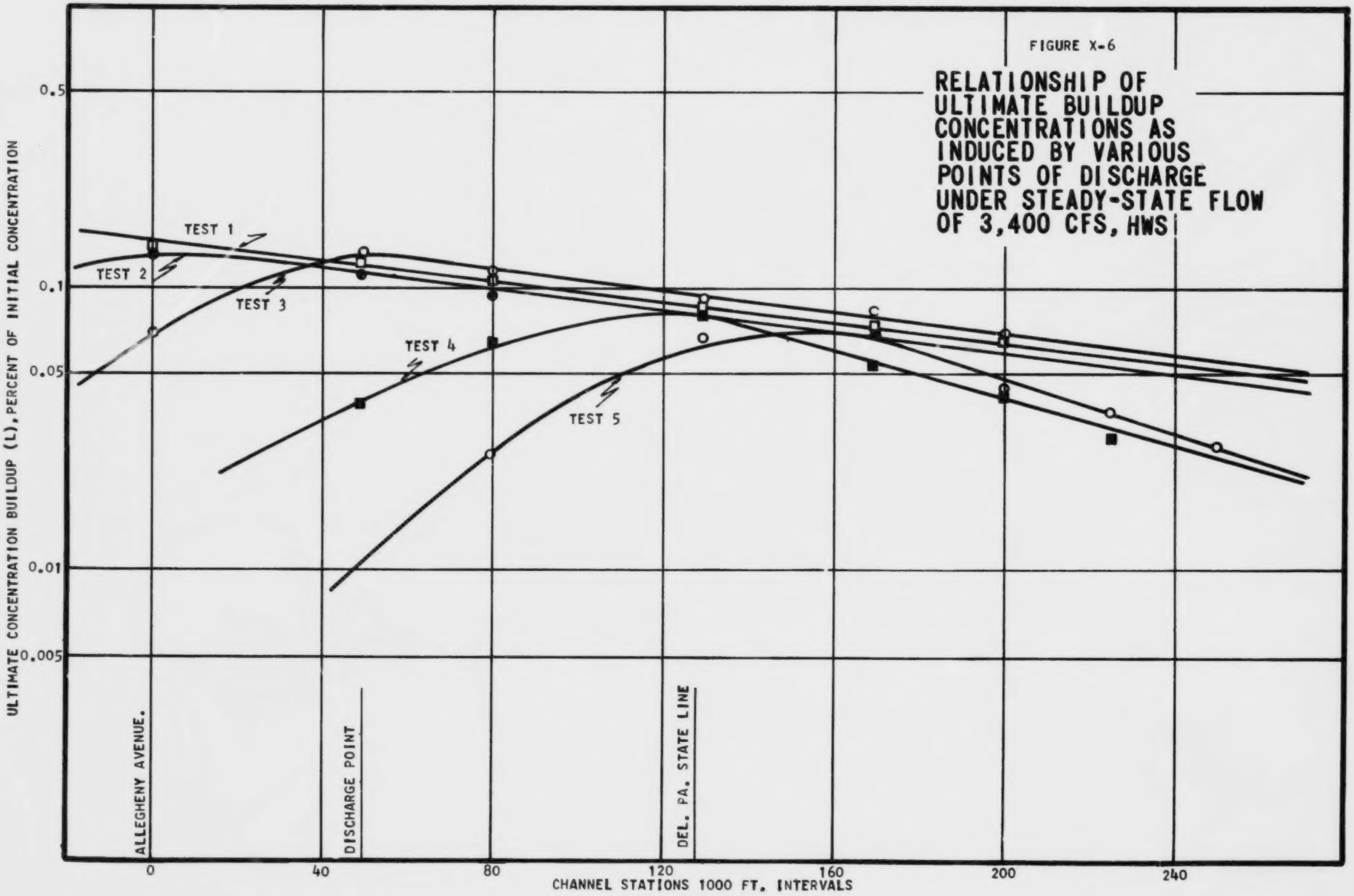


FIGURE X-6

RELATIONSHIP OF ULTIMATE BUILDUP CONCENTRATIONS AS INDUCED BY VARIOUS POINTS OF DISCHARGE UNDER STEADY-STATE FLOW OF 3,400 CFS, HWS

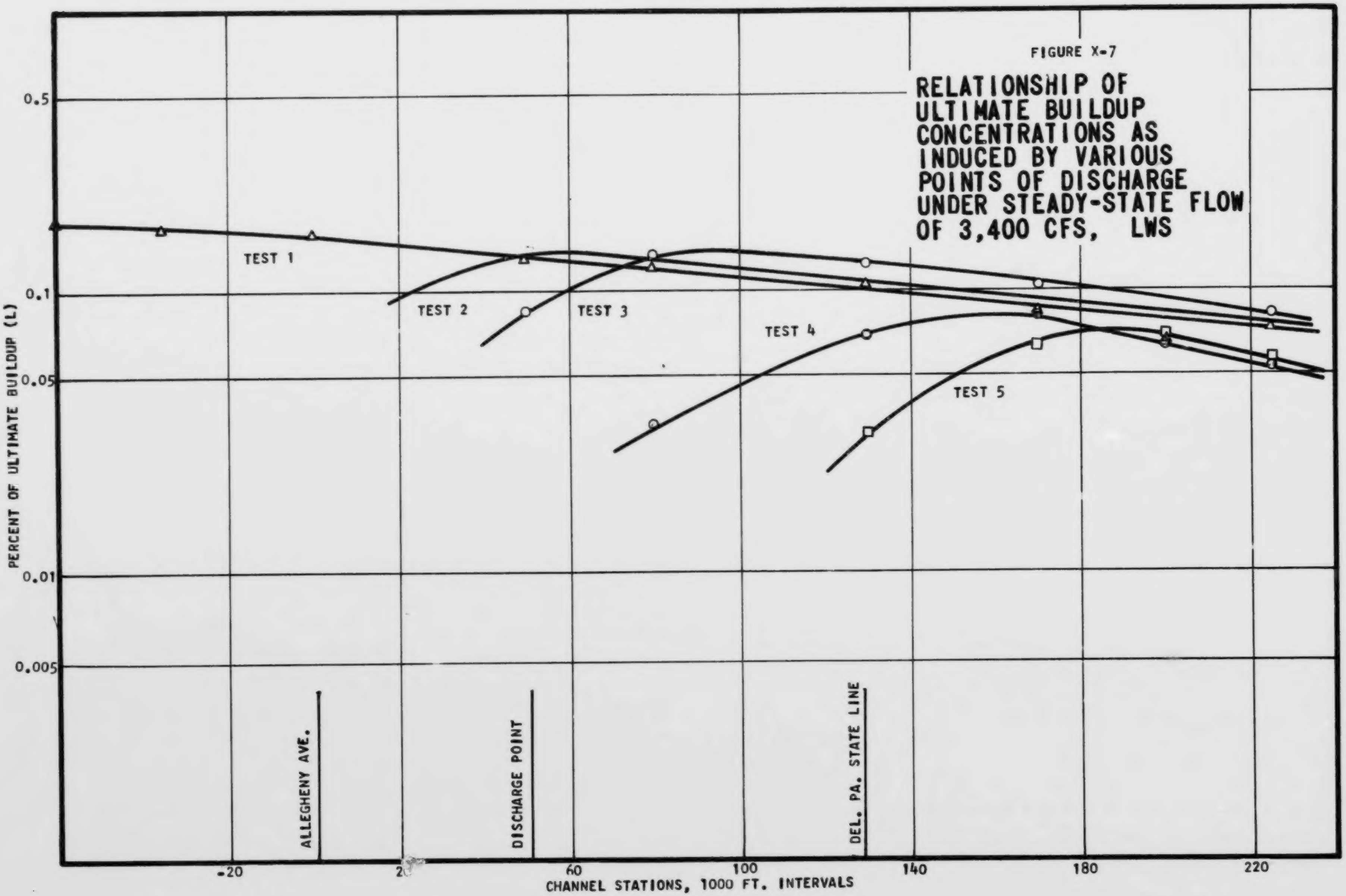


FIGURE X-7

RELATIONSHIP OF ULTIMATE BUILDUP CONCENTRATIONS AS INDUCED BY VARIOUS POINTS OF DISCHARGE UNDER STEADY-STATE FLOW OF 3,400 CFS, LWS

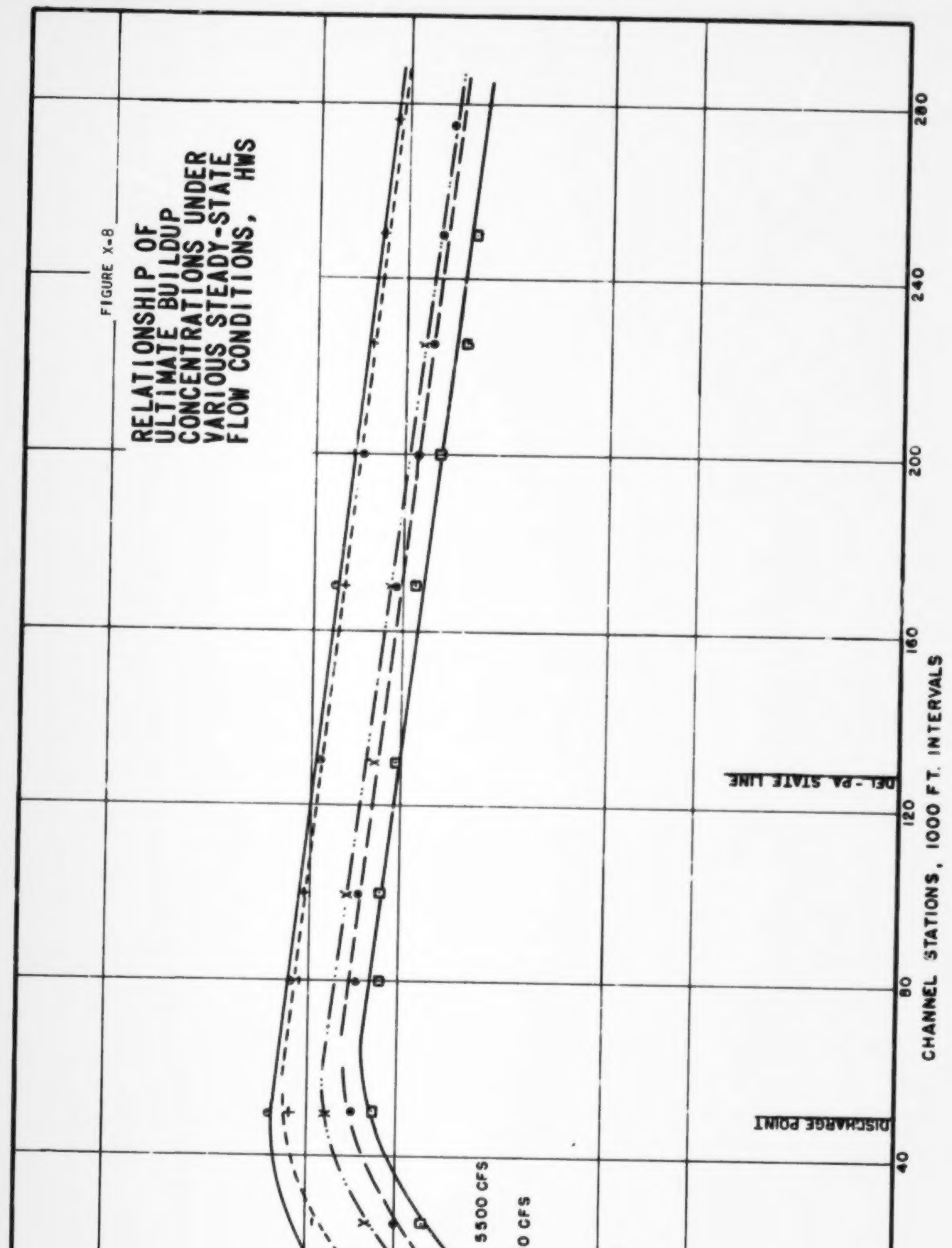


FIGURE X-8

RELATIONSHIP OF ULTIMATE BUILDUP CONCENTRATIONS UNDER VARIOUS STEADY-STATE FLOW CONDITIONS, HWS

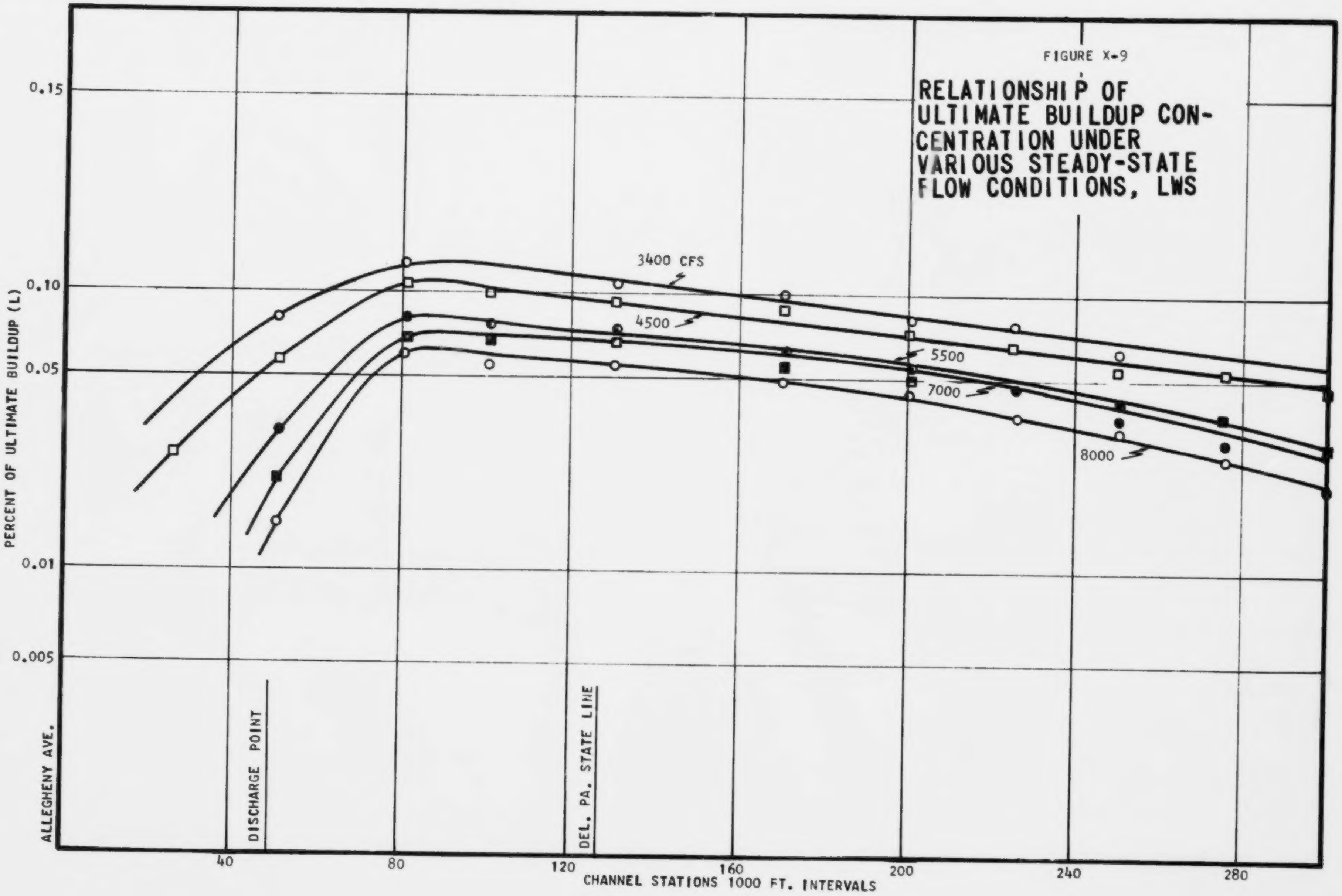


FIGURE X-9

RELATIONSHIP OF ULTIMATE BUILDUP CONCENTRATION UNDER VARIOUS STEADY-STATE FLOW CONDITIONS, LWS

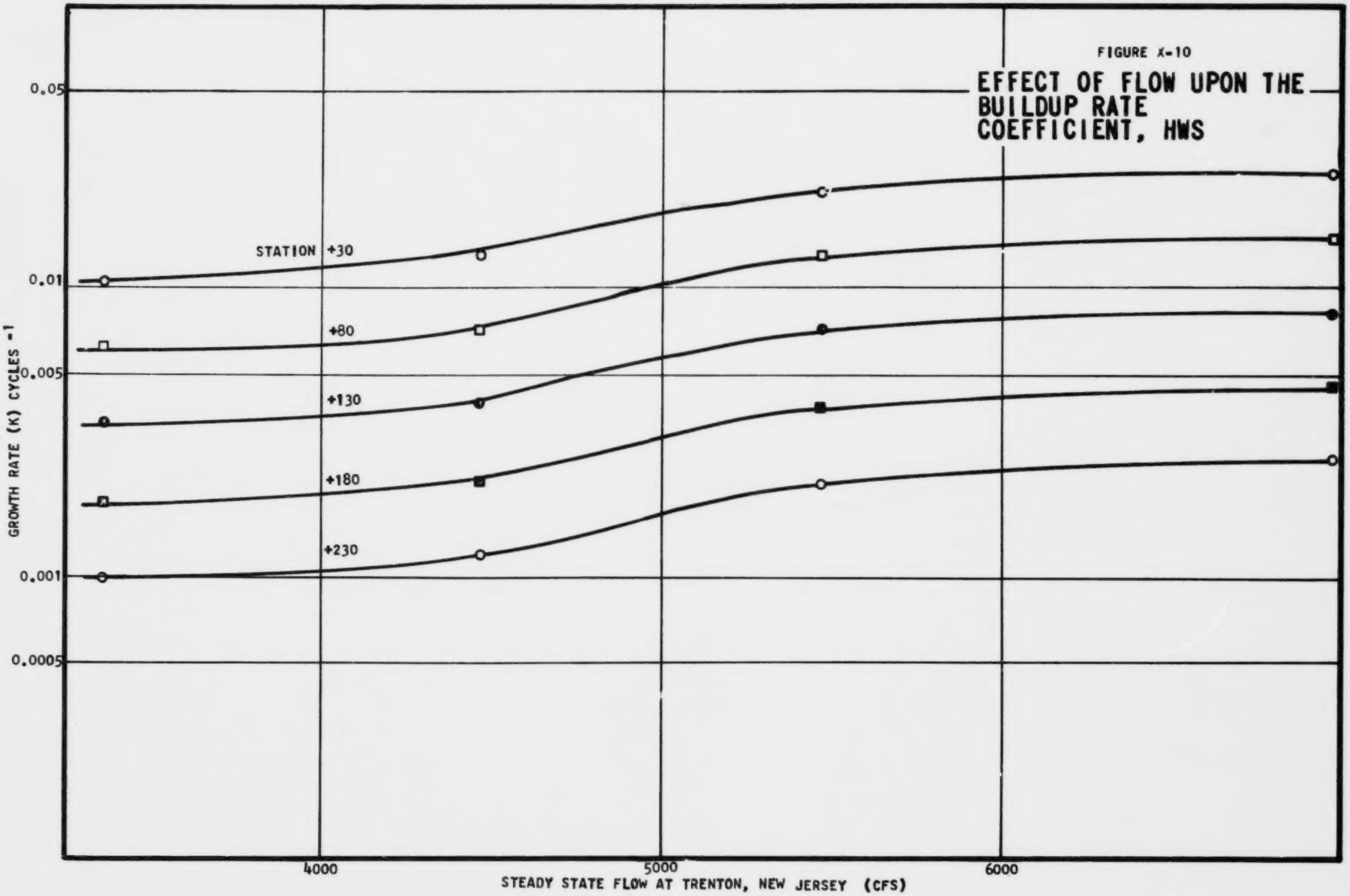


FIGURE X-10

EFFECT OF FLOW UPON THE BUILDUP RATE COEFFICIENT, HWS

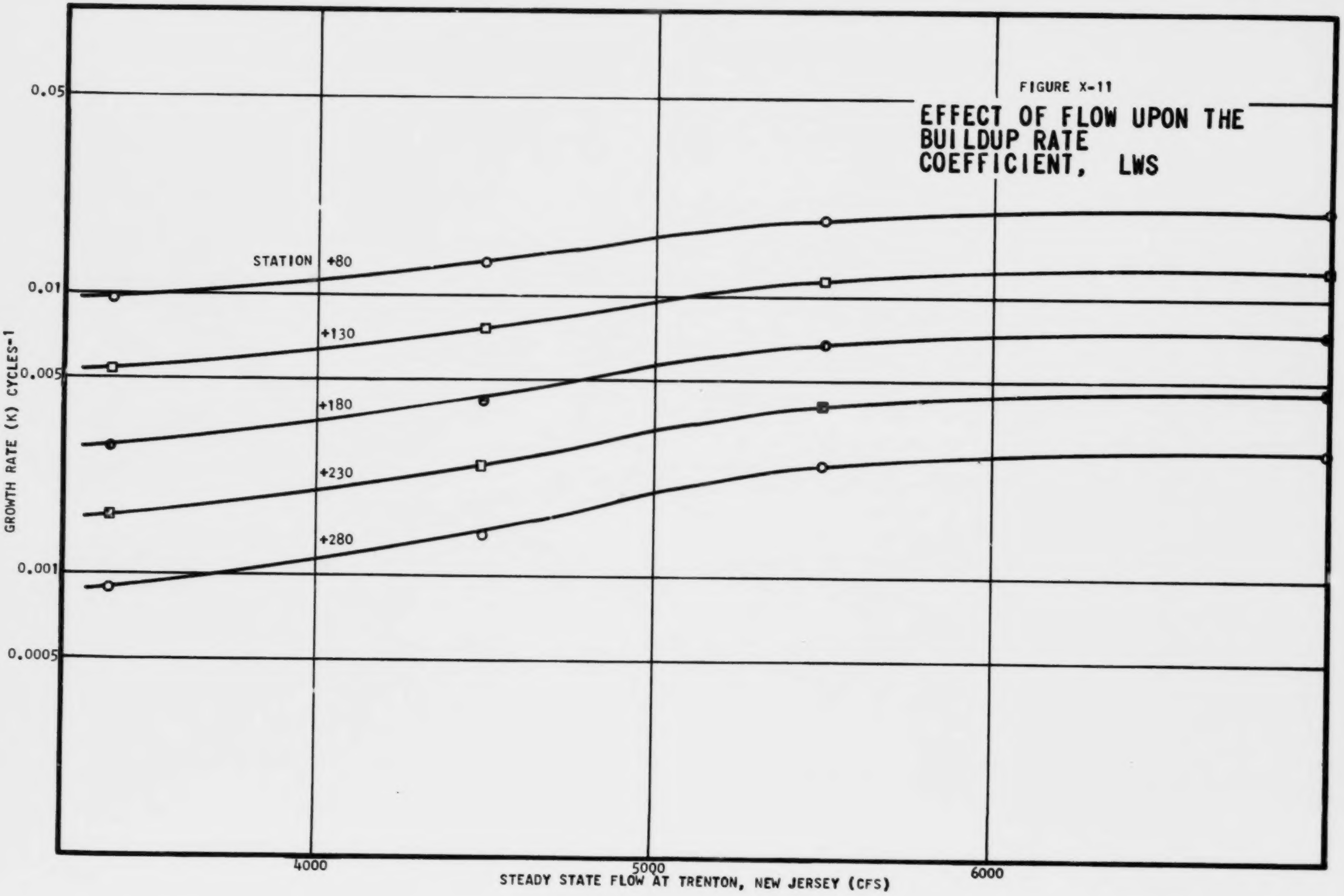
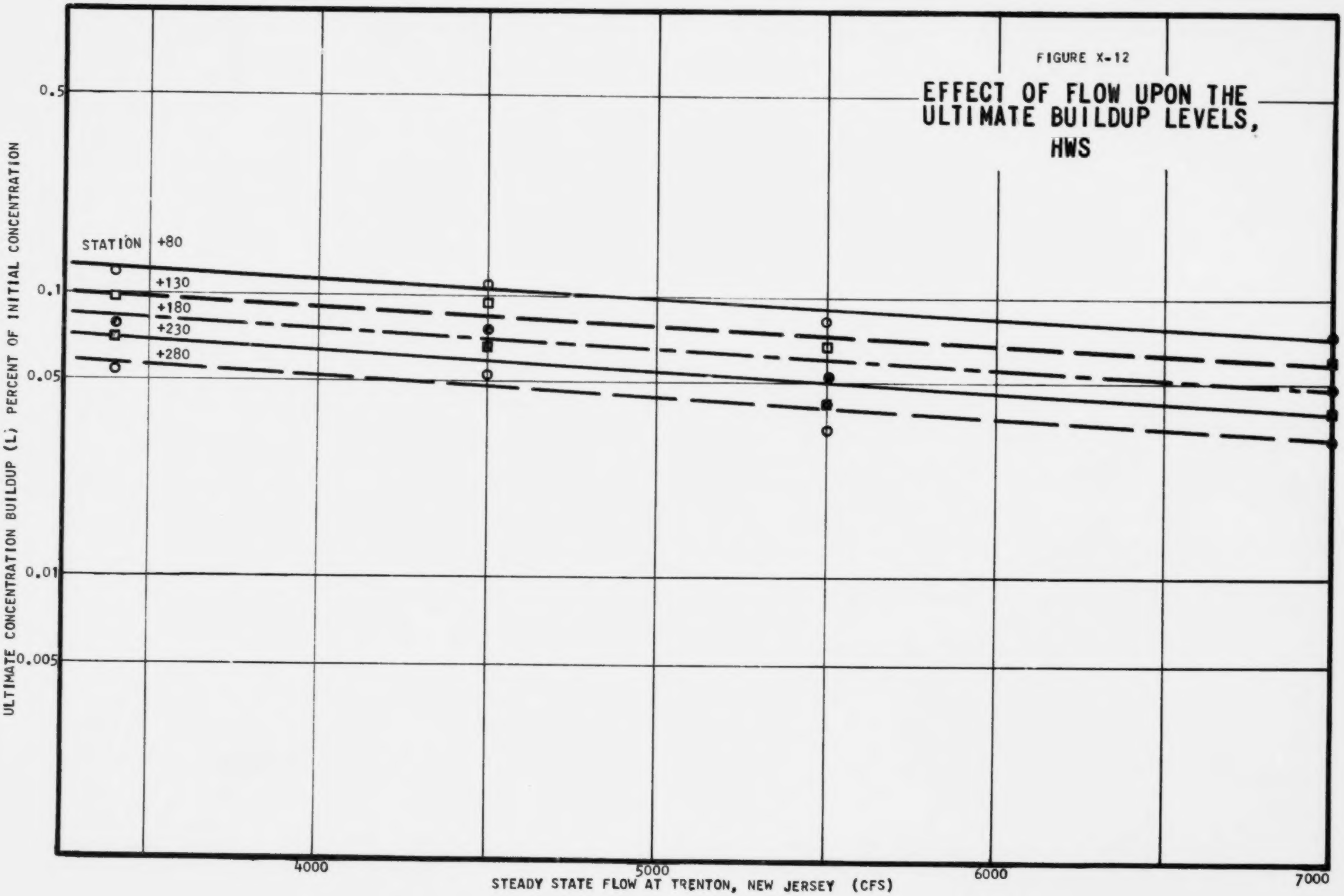


FIGURE X-11

EFFECT OF FLOW UPON THE BUILDUP RATE COEFFICIENT, LWS

FIGURE X-12

EFFECT OF FLOW UPON THE ULTIMATE BUILDUP LEVELS, HWS



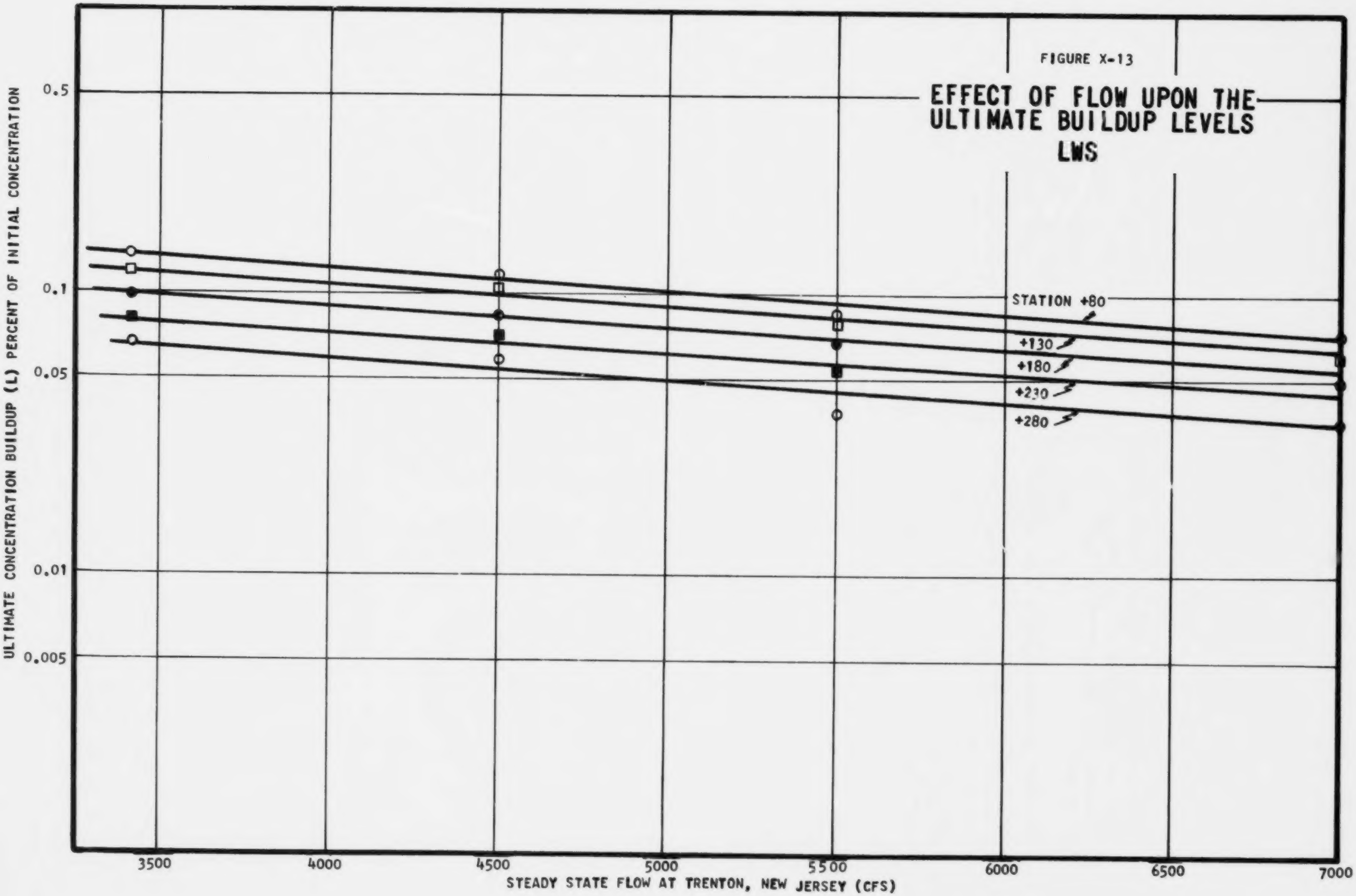


FIGURE X-13

EFFECT OF FLOW UPON THE ULTIMATE BUILDUP LEVELS LWS

CHAPTER XI

MASS ANALYSIS

From a typical buildup curve such as Figure X-1, we can now make a mass analysis to determine the amount of dye present and the location of the center of mass.

The first step in making such an analysis is to construct a mass curve. This is done by selecting concentration readings for a given cycle period from each of the buildup curves from Chapter X and plotting these readings against their station location. The plot result is a curve of the type exemplified in Figure XI-1. This particular curve shows the uncorrected dye concentration at any station in the estuary at 20-cycle intervals for Test 8, (HWS). Similar mass analyses were carried out for each test.

The second step in the mass analysis is to determine the total "mass" of dye in the system after each of the 20-cycle intervals. This is found by multiplying the concentration by the model volume between known stations. Concentration readings are taken from the mass curve at five-station intervals. Each reading is multiplied by the volume of the estuary at that station. The 5-station volume used is that which corresponds to 2500 feet (prototype) upstream and downstream, totaling 5000 feet from the particular location under consideration. The summation for all mass intervals will be the total amount of dye in the estuary. The mass analysis tabulations corresponding to Figure XI-1 are shown in Table XI-1 of the Appendix. A mass analysis was performed for all of the high water slack tests. The total mass after each 20-cycle interval for tests 1 through 9, uncorrected for dye loss, is shown on Table XI-2 of the Appendix.

The third step is to find the location of the center of mass after each 20-cycle interval. This center of mass concerns the station location at which one-half of the total mass is accumulated, after the 5-station volumes have been added in the form of a mass analysis. These locations are listed in Table XI-3 of the Appendix for the continuous release experiments. A plot of these center of mass locations versus tidal cycles (discussed in the dye correction Chapter) shows how the mass moves.

In the continuous release experiments, dye was added at the rate of 100 ml per cycle. The concentration of this dye was 913 ppm. This meant that after 20 cycles, 1,826,000 (micrograms) or 1.826 grams of dye had been added. This figure can be compared to the amount of dye accounted for in the mass analysis. A comparison has been made for tests (1-9) after each 20-cycle period. These uncorrected comparisons are shown in Table XI-4 of the Appendix as a ratio of the amount added to the amount measured. The loss of dye is evidently quite significant.

The above four steps are not enough to give a complete picture or description of the mass movement, or amount of dye accounted for in a continuous dye release system. Further considerations should and will be given to the amount of dye lost by various phenomena and will appear in Chapter XIII on Dye Loss.

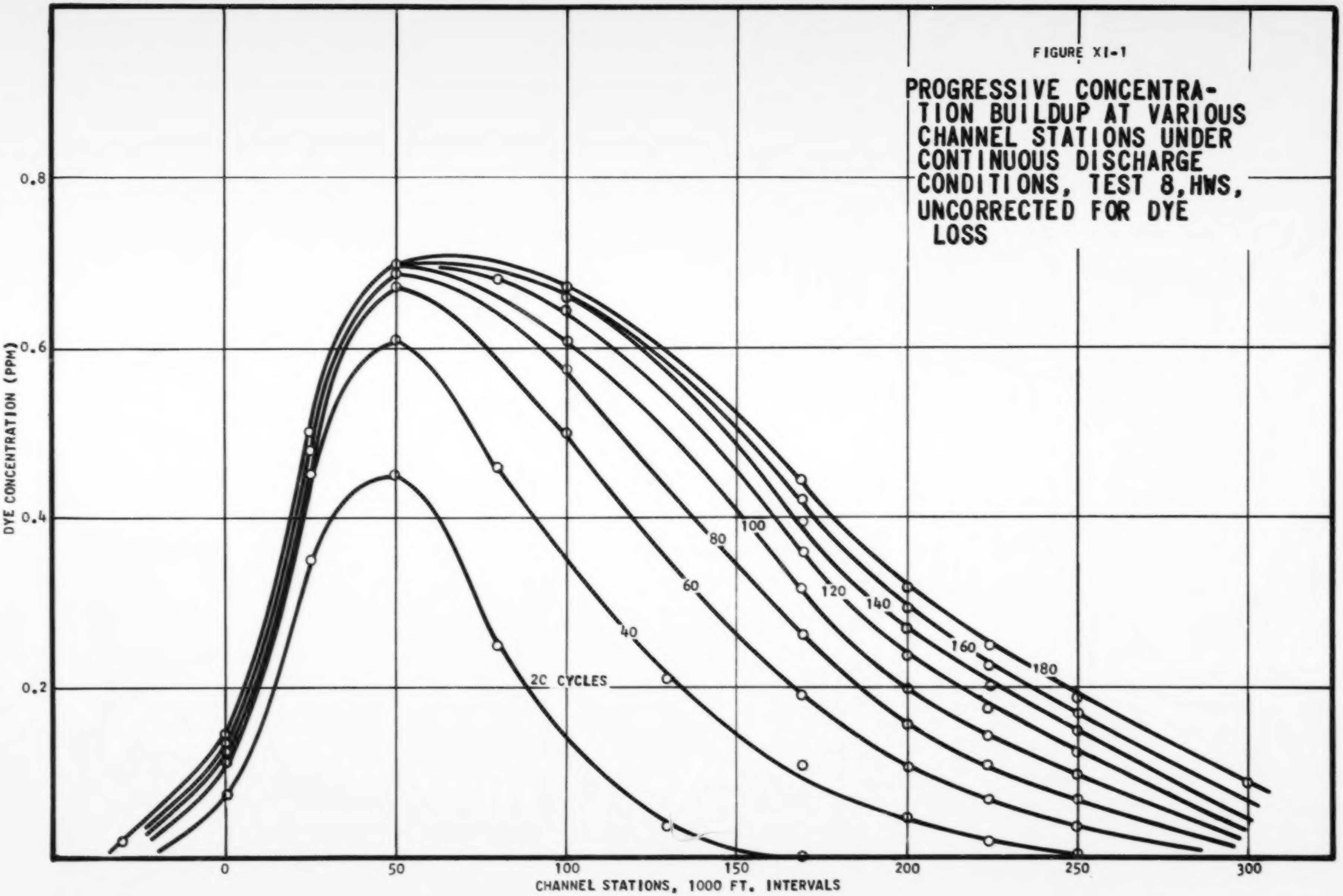


FIGURE XI-1

PROGRESSIVE CONCENTRATION BUILDUP AT VARIOUS CHANNEL STATIONS UNDER CONTINUOUS DISCHARGE CONDITIONS, TEST 8, HWS, UNCORRECTED FOR DYE LOSS

CHAPTER XII

TRANSIT TIME

The instantaneous release type experiments were designed to supplement existing information on transit time in the estuary. Experiments 10, 11, and 12 were made at flows of 3,400 cfs, 7,000 cfs, and 12,350 cfs, respectively, with dye released instantaneously at station +00 (Allegheny Avenue, Philadelphia). Figures XII-1 through XII-3 show the high water and low water slack results of these experiments. These plots show not only the manner in which peak concentration decreases with time, but the location of the peak concentration and center of mass are plotted as functions of time.

Two additional instantaneous release tests (Incodel tests 13 and 14) were performed with the dye release being made at station -155 (Trenton, New Jersey). The flow for test 13 was 3,400 cfs; for test 14 it was 5,500 cfs. Figures XII-4 and XII-5 present the results of these experiments in the same manner as the others. The conditions for each test are summarized in Chapter VIII, Table VIII-1.

To show the continuity of flow in the estuary, the center of mass movement of Incodel tests 10 and 13 (both 3,400 cfs flow), were combined with Waterways Experiment Station test 9 (27). The resultant plot is shown in Figure XII-6. Results of instantaneous release experiments performed at flows of 5,500 cfs and 12,350 cfs are presented in the same manner in Figures XII-7 and XII-8.

These plots indicate that the Delaware Estuary is a continuous system. The center of mass of a contaminant released instantaneously at any point will move in a predetermined manner, depending only on the flow in the river.

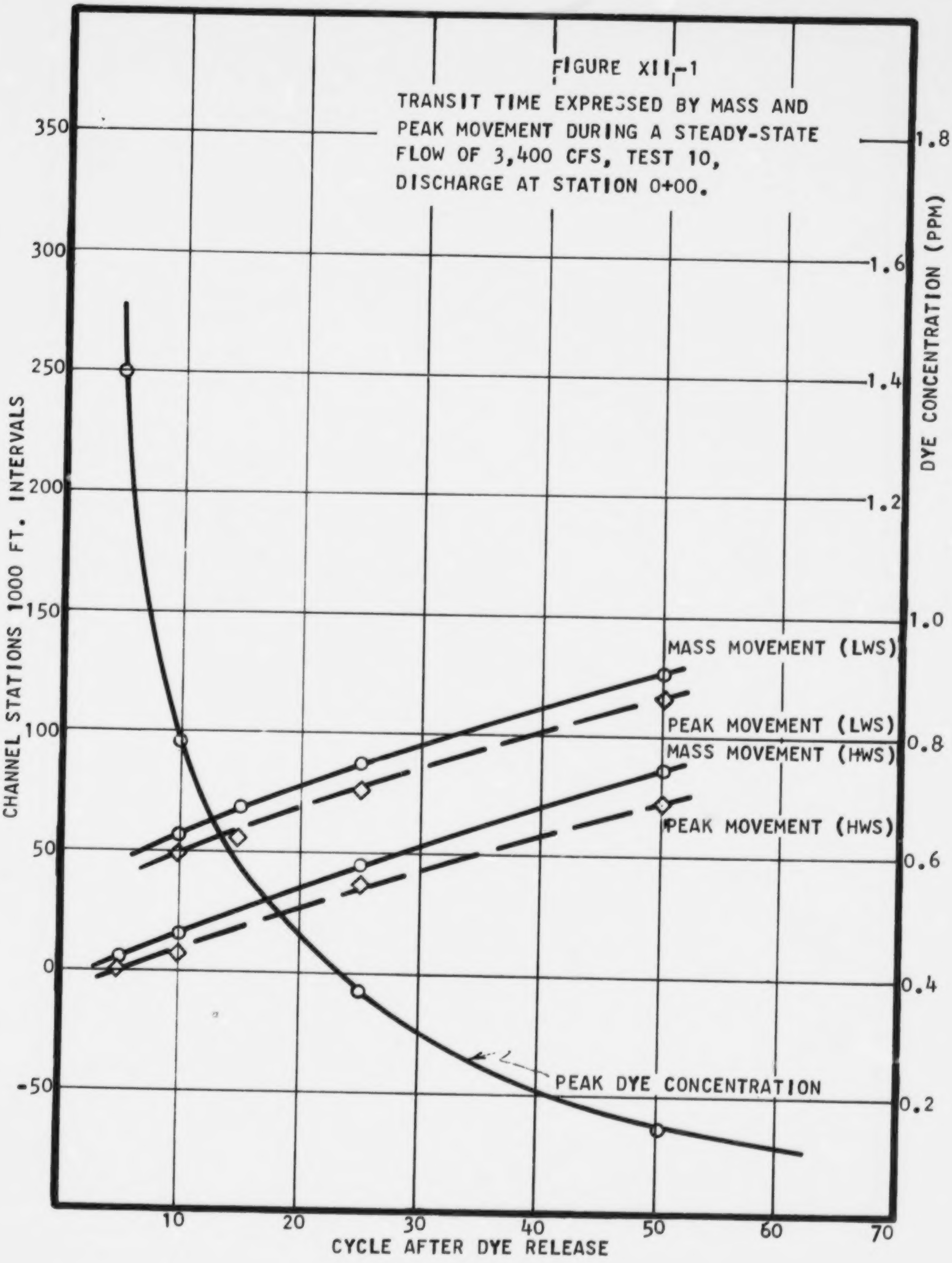


FIGURE XII-1
TRANSIT TIME EXPRESSED BY MASS AND PEAK MOVEMENT DURING A STEADY-STATE FLOW OF 3,400 CFS, TEST 10, DISCHARGE AT STATION 0+00.
CHANNEL STATIONS 1000 FT. INTERVALS
350
300
250
200
150
100
50
0
-50
DYE CONCENTRATION (PPM)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
MASS MOVEMENT (LWS)
PEAK MOVEMENT (LWS)
MASS MOVEMENT (HWS)
PEAK MOVEMENT (HWS)
PEAK DYE CONCENTRATION
10
20
30
40
50
60
70
CYCLE AFTER DYE RELEASE

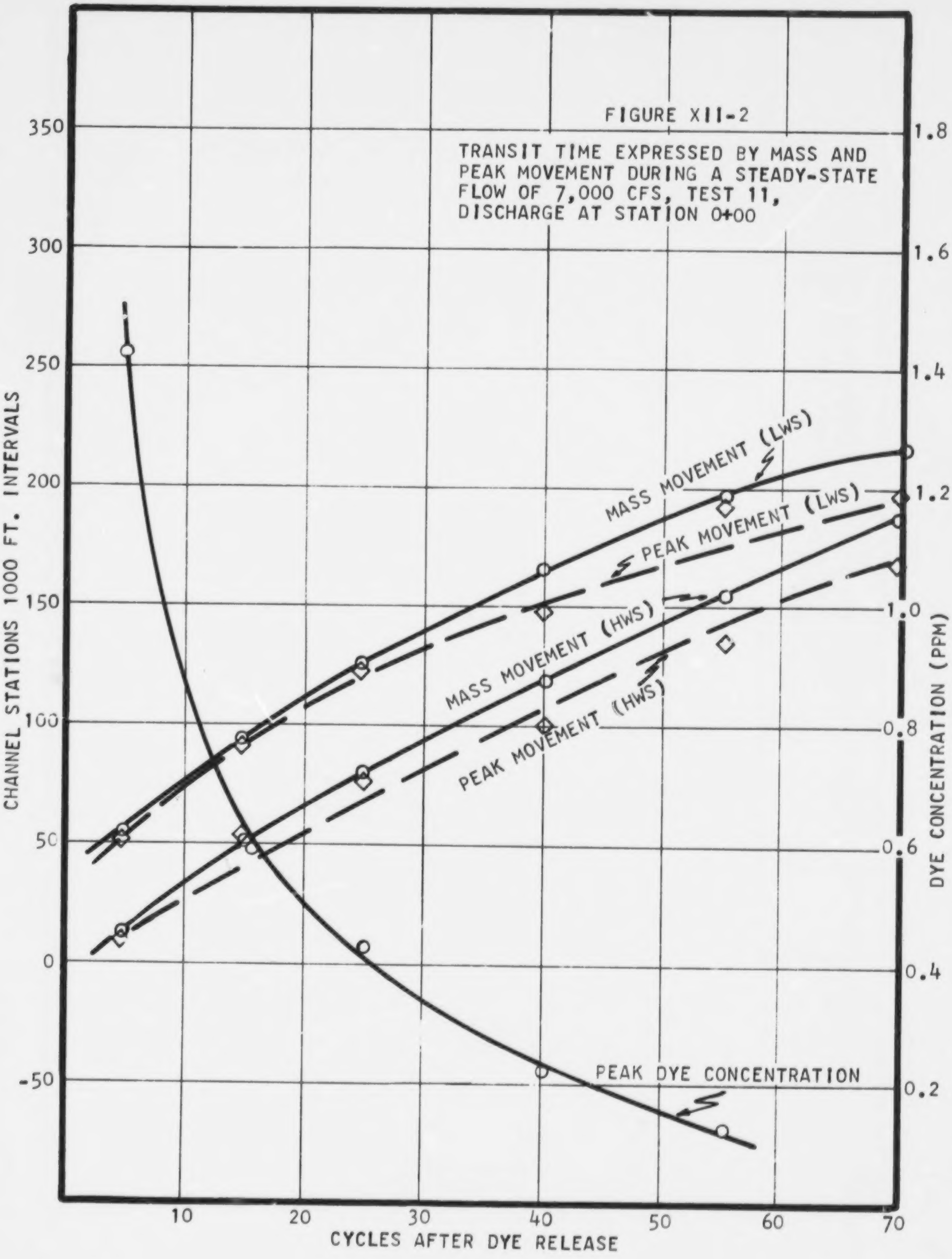


FIGURE XII-2

TRANSIT TIME EXPRESSED BY MASS AND PEAK MOVEMENT DURING A STEADY-STATE FLOW OF 7,000 CFS, TEST 11, DISCHARGE AT STATION 0+00

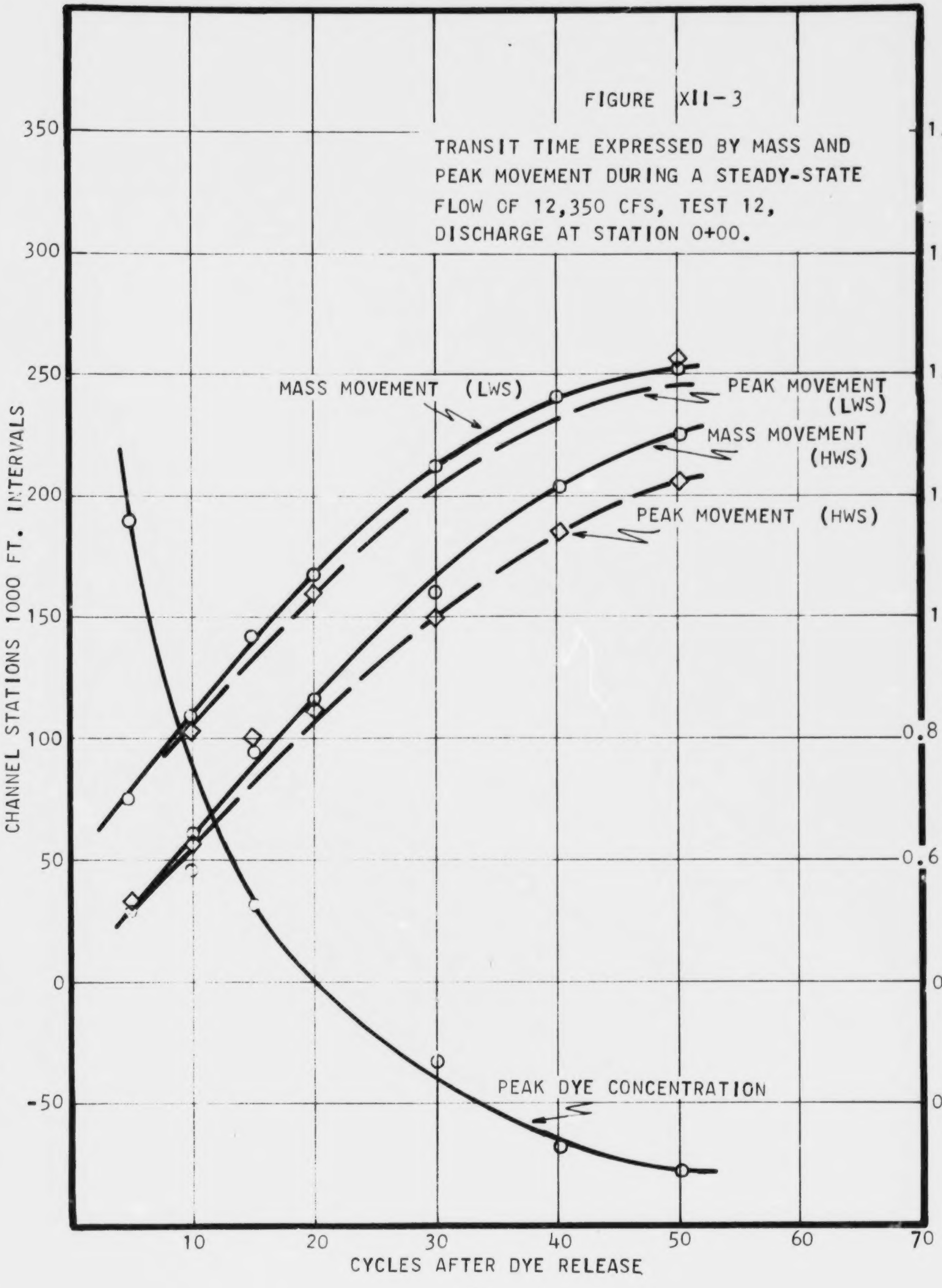


FIGURE XII-3

TRANSIT TIME EXPRESSED BY MASS AND PEAK MOVEMENT DURING A STEADY-STATE FLOW OF 12,350 CFS, TEST 12, DISCHARGE AT STATION 0+00.

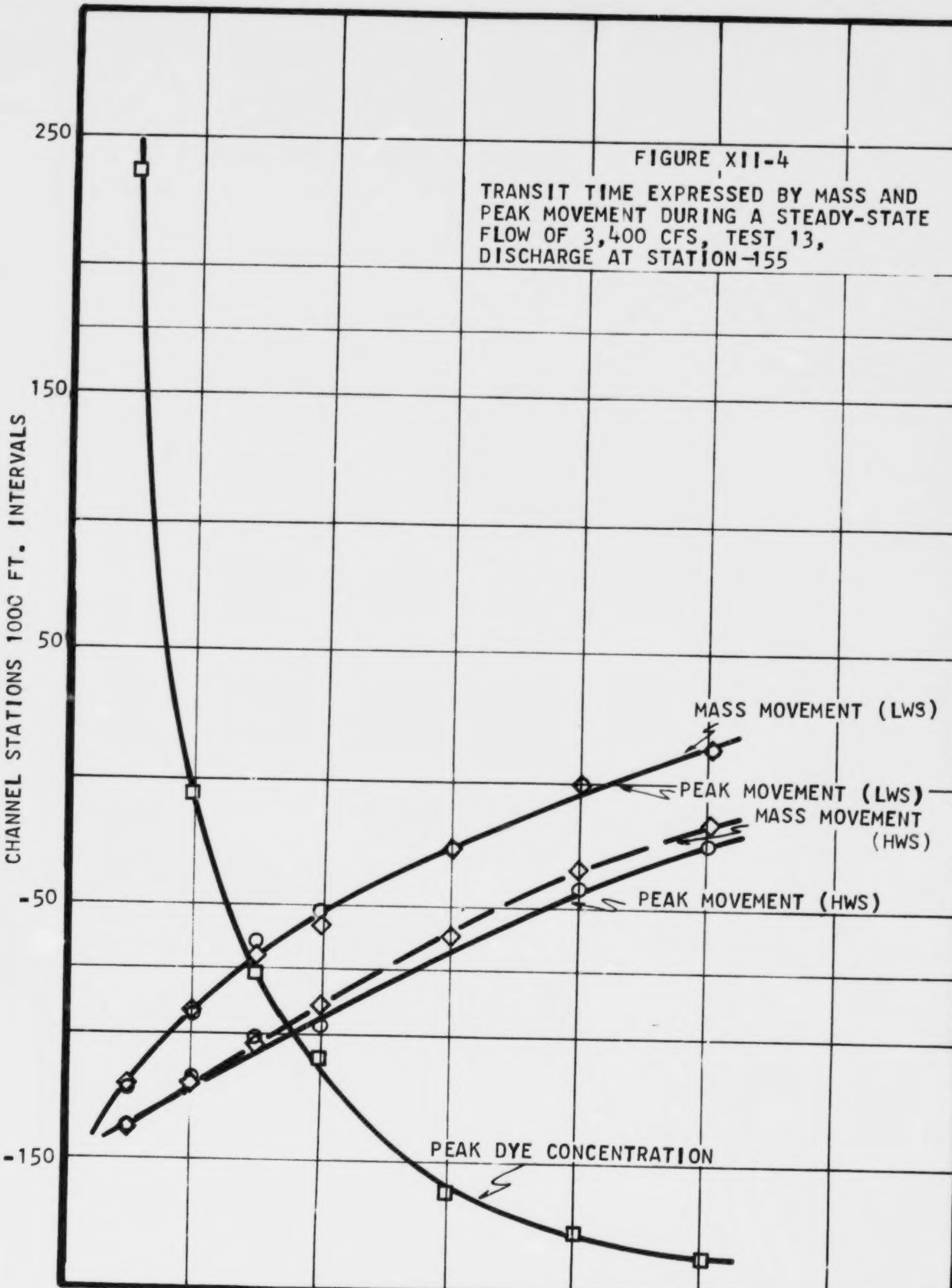


FIGURE XII-4

TRANSIT TIME EXPRESSED BY MASS AND PEAK MOVEMENT DURING A STEADY-STATE FLOW OF 3,400 CFS, TEST 13, DISCHARGE AT STATION-155

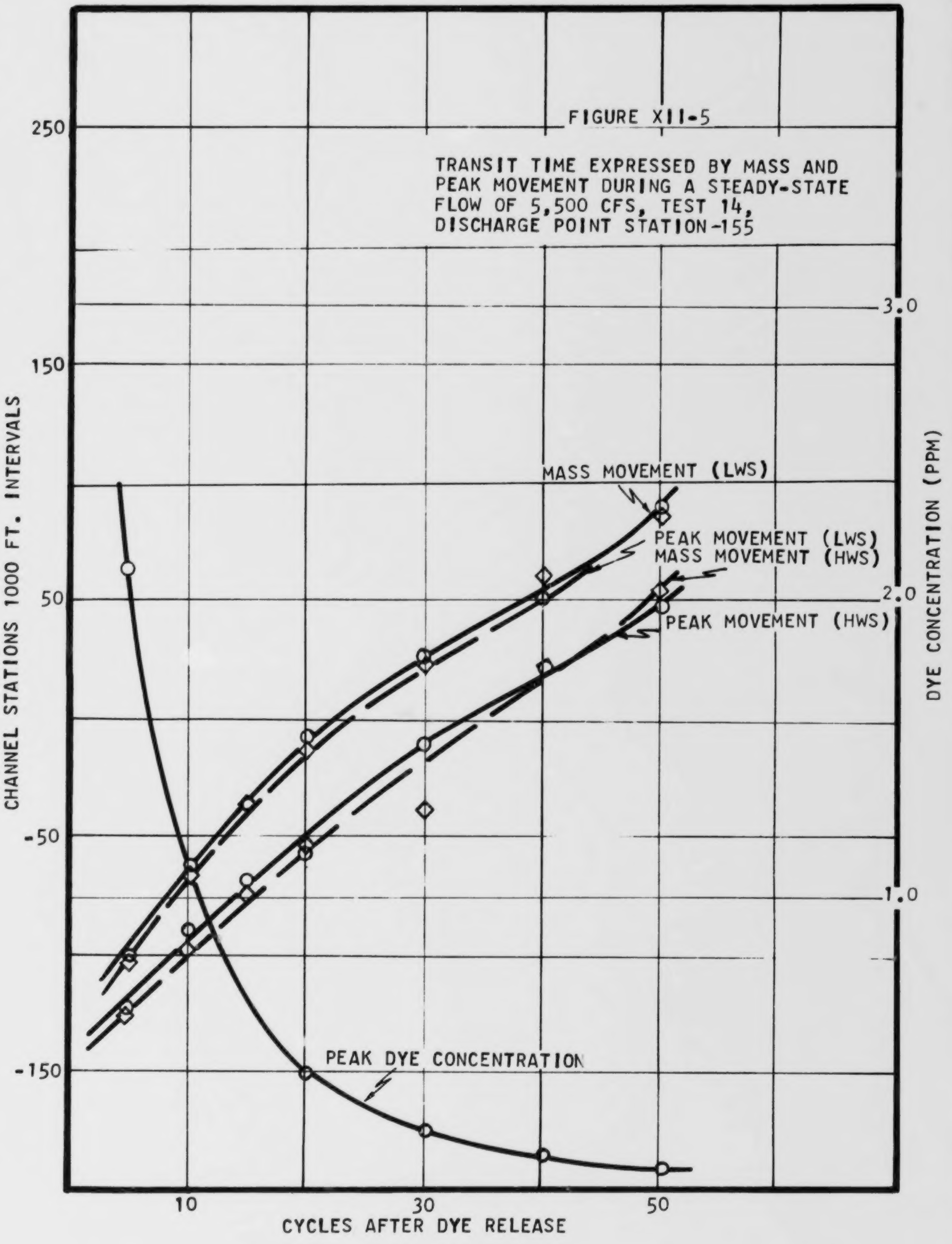


FIGURE XII-5

TRANSIT TIME EXPRESSED BY MASS AND PEAK MOVEMENT DURING A STEADY-STATE FLOW OF 5,500 CFS, TEST 14, DISCHARGE POINT STATION-155

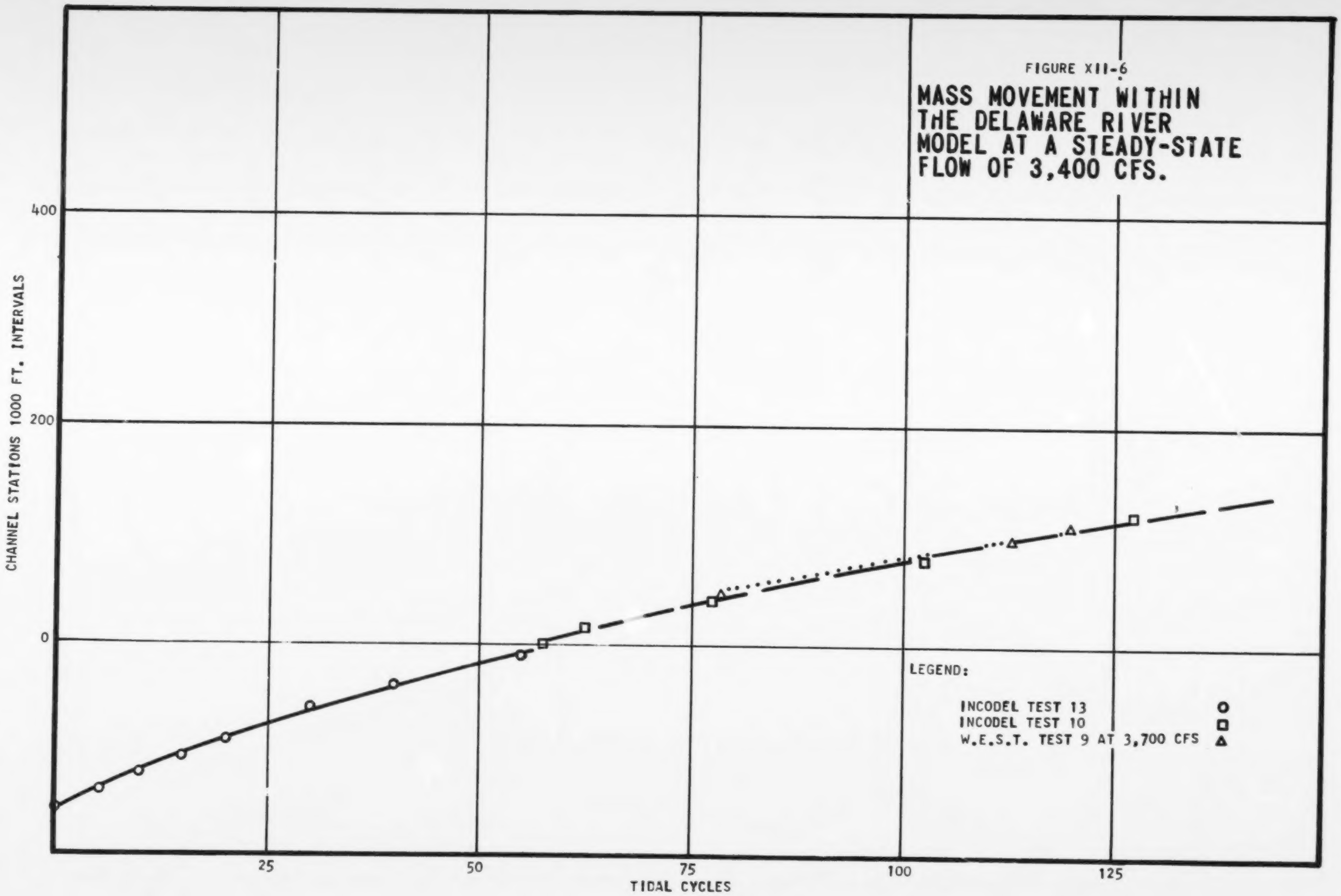


FIGURE XII-6

MASS MOVEMENT WITHIN THE DELAWARE RIVER MODEL AT A STEADY-STATE FLOW OF 3,400 CFS.

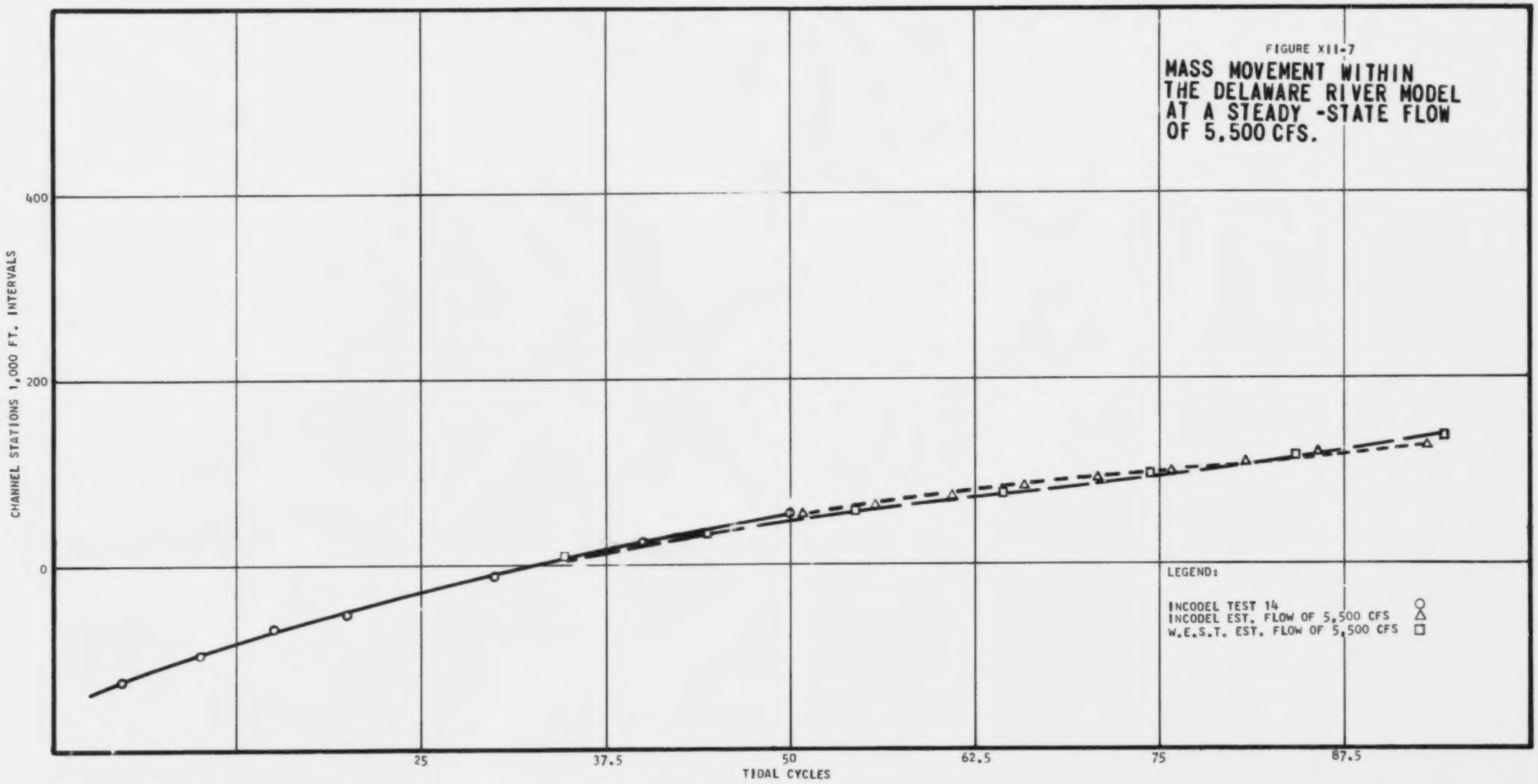


FIGURE XII-7

MASS MOVEMENT WITHIN THE DELAWARE RIVER MODEL AT A STEADY -STATE FLOW OF 5,500 CFS.

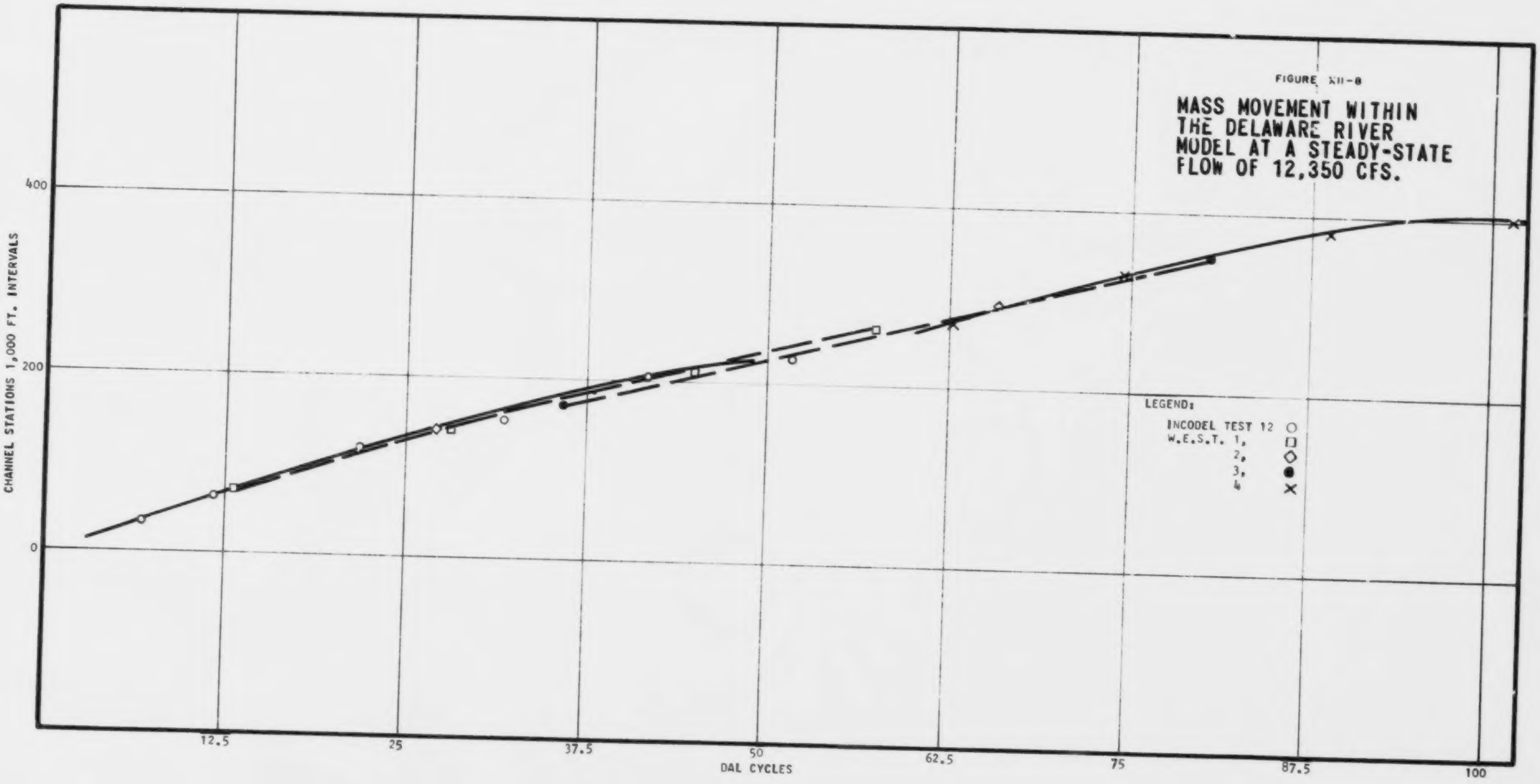


FIGURE XII-8

MASS MOVEMENT WITHIN THE DELAWARE RIVER MODEL AT A STEADY-STATE FLOW OF 12,350 CFS.

CHAPTER XIII

DYE LOSS CORRECTION PROCEDURE

A. General

In performing hydraulic experiments employing methylene blue hydrochloride, in the Delaware River Model at Vicksburg, a loss of dye will occur. This loss is immediately recognized if one compares (Chapter XI) the actual mass of dye in solution with the total mass added prior to the time of measurement. This discrepancy in dye is dependent upon several factors: time or length of exposure, concentration of dye, and/or the wetted perimeter area. Further, consideration must be given to the type and manner of dye addition, namely, whether the dye is added instantaneously or in a continuous manner. Also of importance is whether a portion of the dye, during the experimentation, will have reached areas where no measurements were made.

If the primary objective is to establish a time of transit throughout the river, at a specific flow stage, a single instantaneous release of dye into the model in an upstream area will provide the information required. The center of mass can be found at different intervals of time throughout the experiment which will result in essentially the average movement-time seaward. The peak dye concentration thus formed will also move seaward at a rate established by the river flow and will be evident from the continually declining peaks of concentration with time. The Waterways Experiment Station has shown through various tests the amount of dye loss with time and concentration within the model. These time dye-loss corrections, if applied, will not alter the transit time established by the center of mass on uncorrected dye data. Time-loss corrected data result in higher maxima but do not alter transit-time observations. Consequently, instantaneous dye release experiments performed solely for the purpose of establishing transit-time, need not be corrected for dye loss since observations made on uncorrected data are essentially identical with those of corrected data.

The time-concentration correction factor employed by the Waterways Experiment Station did not take into consideration the larger surface area or wetted perimeter which exists progressively downstream. However, the effect of surface area as shown in the Incodel experiments does not appear significant in areas upstream from Station +170 (Cherry Island). Further, it may also be observed from instantaneous release experiments, of the Incodel series, that the peaks formed during consecutive periods of time are no longer evident in areas downstream from Station +170. Therefore, the effect of increased wetted perimeter downstream, if taken into consideration, would not materially change the observations made from the instantaneous dye release experiments.

Dye corrections made on the Waterways Experiment Station data for the instantaneous release experiments are readily done because the dye at any given time of measurement is of equal age. However, tests performed under continuous dye release conditions and measured at given intervals of time, are not of equal age. Consequently, the method of correction employed must take this fact into consideration.

A further consideration must be made with respect to dye loss in several of the continuous dye release experiments (Incodel tests 6, 8, and 9), because a portion of the dye passed Station +300 and into the Bay area. Due to the unreliability of sampling in areas downstream from Station +300, no measurements were made for dye in that lower reach. Consequently, it becomes necessary in experiments of long duration, and those made in the lower reach of the estuary, that a means of estimating the dye loss to the Bay be included.

A similar analogy with regard to neglecting dye loss corrections might be made for the continuous dye release tests as were made for the instantaneous release experiments. However, the continuous release experiments were conducted primarily to establish not only the rate of buildup of conservative pollutant within the estuary, but also to establish the ultimate concentration of contaminant which could occur. Consequently, any dye loss which would effect the maximum concentration becomes quite significant, and dye loss correction must, of necessity, apply to all continuous-release-type experiments. However, as in the instantaneous test series, certain conclusions can be drawn from uncorrected continuous dye release experiments. In any series of tests conducted under similar conditions, curves have the same relative relationship to each other before and after the application of dye loss corrections.

For the purpose of expediency, the complete dye loss correction procedure will be applied to a single experiment (Test 8), since it involves a Bay loss correction. It may be recalled that Test 8 was a continuous dye release test in which the Trenton flow was maintained at 7,000 cfs. The methylene blue dye was added continuously in the amount of 100 ml per tidal cycle and in a concentration of 913 ppm. Further, this experiment was continued for 180 tidal cycles which showed, after approximately 100 tidal cycles, a significant portion of the dye had entered the Bay area, thus constituting a Bay loss.

Mass of dye found in each continuous dye release test, after 20-cycle intervals, was determined from the mass curves. These uncorrected tabulations were shown in Table XI-2 of the Appendix for Incodel tests 1 through 9. In order to develop the mass curves, the uncorrected dye data were plotted and inserted into an analog computer (See Chapter X). The curve of best fit was established whereby the rate of buildup and the maximum or ultimate dye concentrations were derived for each curve at each specific station location. From these computer curves, plots were made to form mass curves after each 20-cycle interval.

A comparison of dye added in any period to the corresponding dye found at the end of that period (20 cycles, 40 cycles, etc.), shows a very significant loss of dye. The ratio of the dye added to the dye found has been termed "dye correction factor". The dye correction factors for tests 1-9 are presented in Table XI-4 of the Appendix.

In calculating the correction factors in Table XI-4 of the Appendix, the amount of dye added was taken as 100 ml. of 1,000 ppm concentration per tidal cycle. This is the figure originally reported by the Waterways Experiment Station. Further checking by the Experiment Station revealed that the dye being added was 913 ppm. This change could conceivably be attributed to the absorption of moisture by the dye while in storage. With this new correction, the dye correction factors were tabulated and are shown in Table XIII-1.

Center of mass movement, recorded as 1,000 foot stations, was shown in Table XI-3 of the Appendix. These mass movements are for continuous dye releases and do not represent transit time as such, however, they do show the relatively slower movement downstream during a continuous release than during an instantaneous release condition.

B. Effect of Time - Concentration

The Waterways Experiment Station performed a series of tests to determine the effect of time and concentration on dye loss. In this series of experiments, different dye concentrations were tested in the model at various locations and intervals of time. The remaining dye concentrations were also measured. The data were compiled, averaged, and plotted, to produce the curve on Figure XIII-1. From this dye loss curve, "time-

TABLE XIII - 1

DELAWARE RIVER MODEL TEST
SERIES 1-9, (HWS)
INITIAL DYE CORRECTION FACTOR CORRECTED FOR 913 ppm

	AFTER CYCLE NUMBER								
Test No.	20	40	60	80	100	120	140	160	180
1.	1.20	1.41	1.48	1.56	1.63	1.73	1.82	1.87	1.92
2.	1.15	1.28	1.39	1.48	1.60	1.75	1.84	1.96	2.05
3.	1.46	1.40	1.43	1.51	1.63	1.73	1.88	2.00	2.09
4.	1.50	1.57	1.71	1.87	2.06	2.31	2.53	2.73	2.94
5.	1.40	1.56	1.77	1.97	2.20	2.42	2.66	2.88	3.07
3.	1.46	1.40	1.43	1.51	1.63	1.73	1.88	2.00	2.09
7.	1.25	1.32	1.37	1.47	1.58	1.74	1.83	1.96	2.09
6.	1.35	1.37	1.55	1.69	1.85	2.03	2.19	2.36	2.51
8.	1.51	1.47	1.55	1.70	1.88	2.05	2.33	2.40	2.58
9.	1.57	1.54	1.69	1.88	2.07	2.28	2.49	2.71	2.93

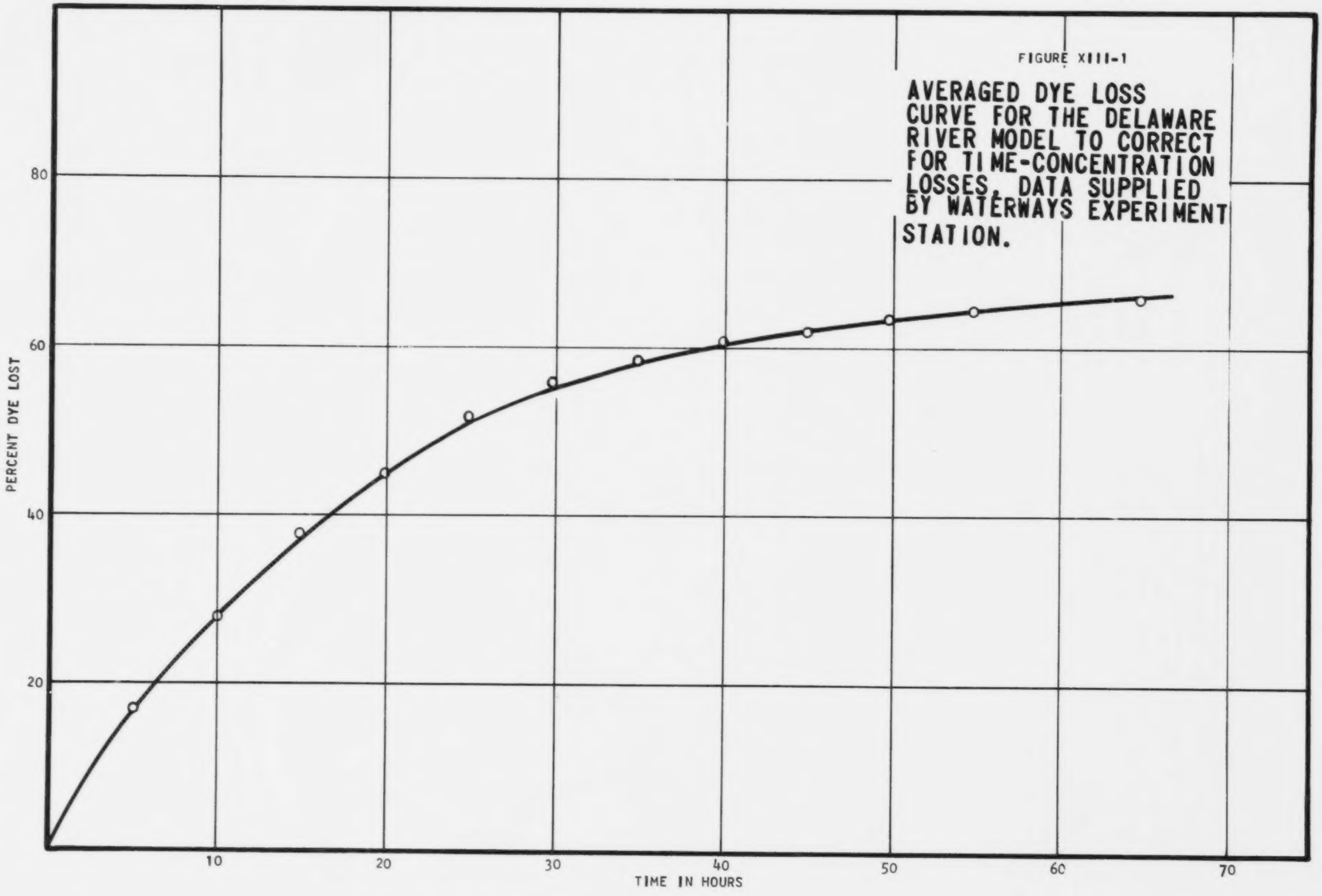


FIGURE XIII-1

AVERAGED DYE LOSS CURVE FOR THE DELAWARE RIVER MODEL TO CORRECT FOR TIME-CONCENTRATION LOSSES, DATA SUPPLIED BY WATERWAYS EXPERIMENT STATION.

concentration correction factors" for each 5-cycle interval was computed and recorded in Table XIII-2. These time-concentration correction factors were made for and are applicable to the instantaneous release tests, namely, Incodel tests 10-14. However, as explained above, this correction was not to be applied to tests 10-14 since the correction factors would not change the corresponding transit-time values. Before the time-concentration correction factor can be applied to the continuous data, an allowance must be made for the fact that the dye measured is not of the same age. The method of correction will be explained below using Incodel Test 8 (HWS) as an example.

C. Effect of Age

Dividing the uncorrected buildup curve (Figure XIII-2) into small time intervals and then correcting each concentration increment by a corresponding correction (See Table XIII-3), will simulate as closely as possible the static test conditions.

TABLE XIII - 2

DELAWARE RIVER MODEL TEST
DYE LOSS CORRECTION FACTORS FOR TIME AND CONCENTRATION

Cycles	% Lost *	(C. F.) ** Correction Factor
5	2.6	1.03
10	5.5	1.06
15	7.8	1.08
20	9.8	1.11
25	11.6	1.13
30	13.7	1.16
35	15.0	1.18
40	17.2	1.21
45	18.6	1.23
50	20.4	1.26
55	21.9	1.28
60	23.1	1.30
65	24.3	1.32
70	25.8	1.35
75	27.1	1.37
80	28.3	1.39
85	29.6	1.42
90	30.8	1.45
95	32.1	1.47
100	33.4	1.50
105	34.3	1.52
110	35.6	1.55
115	36.8	1.58
120	37.8	1.61
125	39.0	1.64
130	40.0	1.67
135	41.1	1.70
140	42.1	1.73
145	43.1	1.76
150	44.0	1.79
155	45.0	1.82
160	45.9	1.85
165	46.8	1.88
170	47.7	1.91
175	48.6	1.95
180	49.3	1.97

** Correction Factor = $\frac{100}{100 - \% \text{ lost}}$

* From Fig. XIII-1

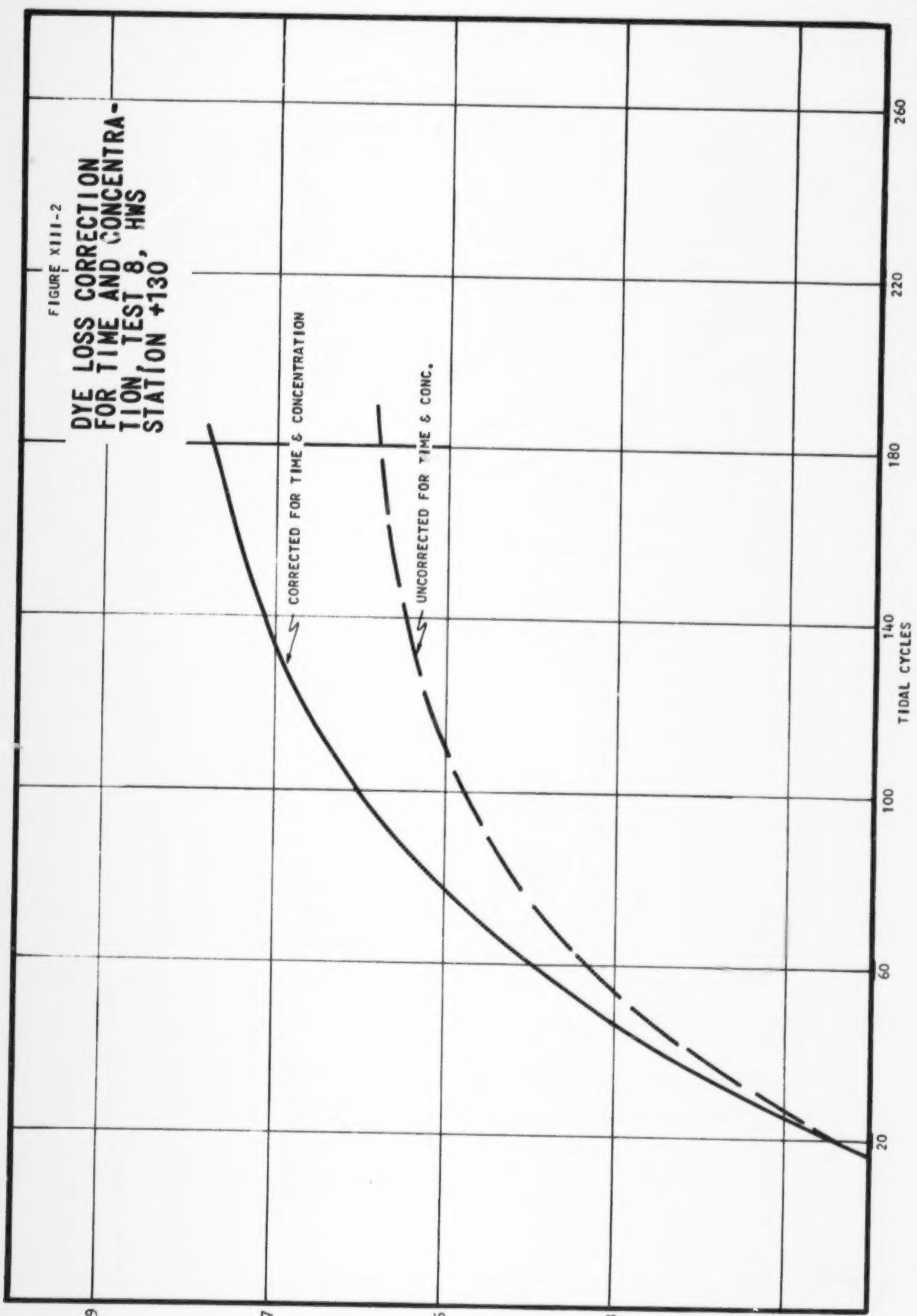


FIGURE XIII-2

DYE LOSS CORRECTION FOR TIME AND CONCENTRATION, TEST 8, HWS STATION +130

TABLE XIII - 3

DELAWARE RIVER MODEL TEST 8 (HWS)
TIME AND CONCENTRATION DYE LOSS CORRECTION FOR STATION +130

Cycles	*Uncorrected Concentration (ppm)	Δ C for 5-cycles	(Δ C) x Correction Factor	Corrected Conc. ** (ppm)
5	-	-	-	-
10	-	-	-	-
15	-	-	-	-
20	0.0034	0.0034	0.0038	0.0038
25	0.0085	0.0051	0.0058	0.0096
30	0.0130	0.0045	0.0052	0.0148
35	0.0172	0.0042	0.0050	0.0198
40	0.0210	0.0038	0.0046	0.0244
45	0.0245	0.0035	0.0043	0.0287
50	0.0278	0.0033	0.0041	0.0328
55	0.0307	0.0029	0.0037	0.0365
60	0.0333	0.0026	0.0034	0.0399
65	0.0358	0.0025	0.0033	0.0432
70	0.0379	0.0021	0.0028	0.0460
75	0.0400	0.0021	0.0029	0.0489
80	0.0418	0.0018	0.0025	0.0514
85	0.0435	0.0017	0.0024	0.0538
90	0.0450	0.0015	0.0022	0.0560
95	0.0464	0.0014	0.0021	0.0581
100	0.0477	0.0013	0.0020	0.0601
105	0.0488	0.0011	0.0017	0.0618
110	0.0499	0.0011	0.0017	0.0635
115	0.0509	0.0010	0.0016	0.0651
120	0.0518	0.0009	0.0014	0.0665
125	0.0526	0.0008	0.0013	0.0678
130	0.0533	0.0007	0.0012	0.0690
135	0.0540	0.0007	0.0012	0.0702
140	0.0546	0.0006	0.0010	0.0712
145	0.0551	0.0005	0.0009	0.0721
150	0.0556	0.0005	0.0009	0.0730
155	0.0561	0.0005	0.0009	0.0739
160	0.0565	0.0004	0.0007	0.0746
165	0.0569	0.0004	0.0008	0.0754
170	0.0572	0.0003	0.0006	0.0760
175	0.0576	0.0004	0.0008	0.0768
180	0.0579	0.0003	0.0006	0.0774

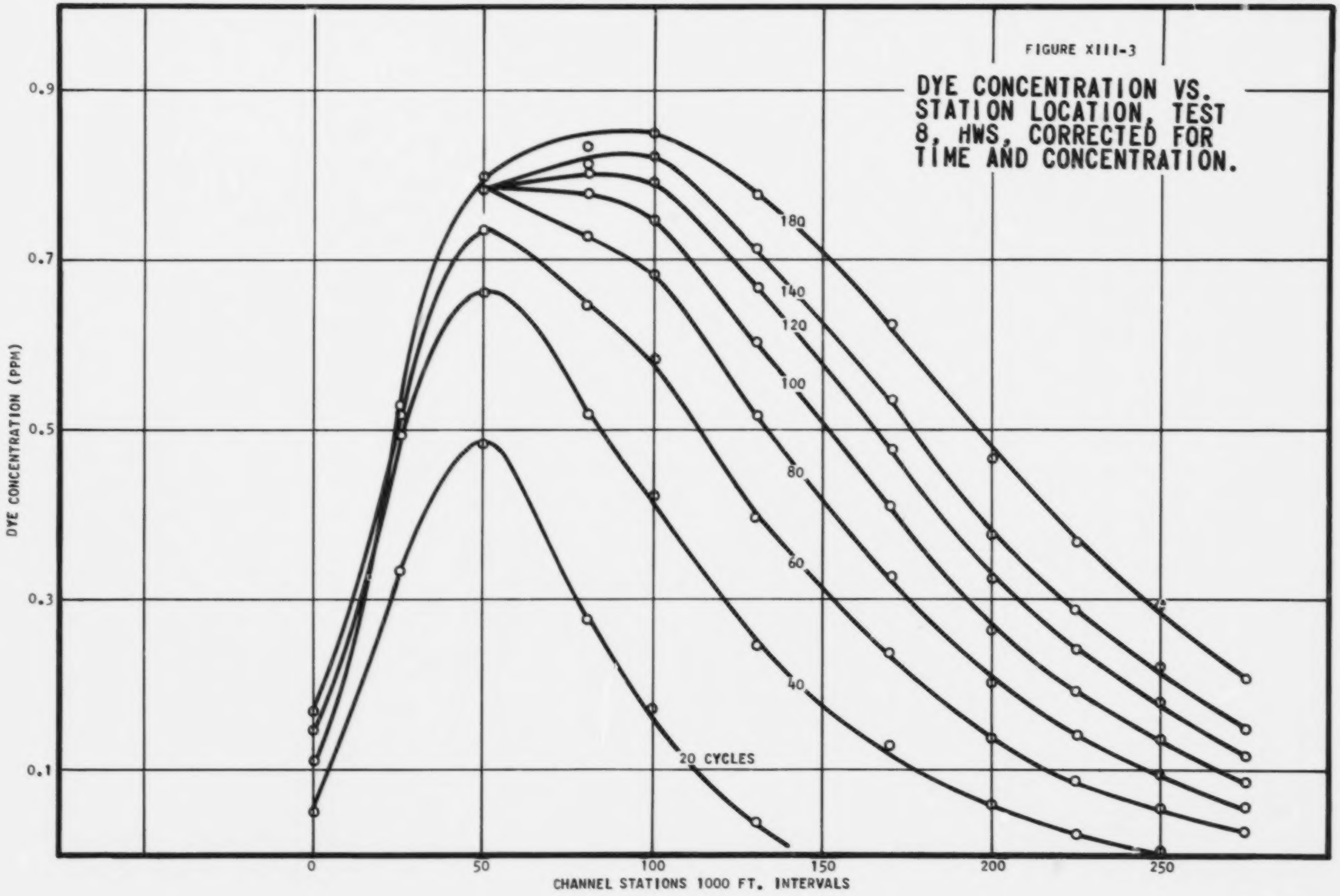
* From BUILDUP curve Fig. XIII-2
**Plotted on Figure XIII-2

The concentration at 5-cycle intervals was selected. The results obtained by using 1-cycle intervals would be more accurate, but would require many more calculations. The small improvement did not warrant the additional work. The concentration after each 5-cycle taken from the buildup curve Figure XIII-2, is corrected by the 5-cycle correction factor (Table XIII-2). The concentration increment from 5- to 10-cycles is corrected by the 10-cycle factor. This procedure is applied to all 5-cycle increments up to 180 cycles. These corrections for Station 130, Test 8, are listed in Table XIII-3 as an example. The "corrected" concentration at any time will be the accumulation of the corrected increments up to the desired time. The corrected buildup curve is also shown in Figure XIII-2. All correction factors shown were taken from a dye loss experiment made at the Waterways Experiment Station by their staff (see Figure XIII-1).

A new mass curve shown in Figure XIII-3 was drawn using these corrected dye loss concentrations. From this curve a second mass analysis

FIGURE XIII-3

DYE CONCENTRATION VS. STATION LOCATION, TEST 8, HWS, CORRECTED FOR TIME AND CONCENTRATION.



was made, similar to that shown in Table XI-1 of the Appendix, except that it incorporated the correction for time and concentration. From the corrected mass analysis, once more the percent of dye accounted for was calculated. These values are shown in Table XIII-4.

D. Effect of Bay Loss

In performing the mass analyses, it was discovered that dye measurements were not made beyond where the Bay begins, (Station +300). Any center of mass tabulation which does not include these Bay losses will result in mass locations short of their correct position. If the Bay losses are correctly accounted for, the resultant center of mass locations would be "weighed" downstream when compared to initial positions. Center of mass locations, excluding Bay losses, were given in Table XI-3 of the Appendix.

In an article by H. S. Thomas, Jr., (26) is described a simple method of description of flow through time distributions that is relatively independent of imperfections or the tracer and sampling techniques. To put a relative value on the Bay losses, the Thomas procedure was carried out. The modal concentration and time of occurrence (T_2) are found. Referring to Chapter XI, Figure XI-1, the 180-cycle modal concentration is 0.698 ppm. This concentration (T_2) occurs at Station +50. The modal concentration is divided by 4, and the Station of occurrence of the 1/4 concentration is found downstream from the point of discharge (T_3). In the example, the 1/4 concentration equals 0.1745 and thus, $T_3 = 257$.

From Figure XIII-3, which contained mass analyses corrected for time and concentration, a plot showing how the location of the center of mass (C. M.) and the T_3/T_2 ratio varied with tidal cycles, was made (Figure XIII-4). A plot was then made showing how the slope of the C. M. and the slope of the T_3/T_2 ratio curve varied with tidal cycles (Figure XIII-5). The T_3/T_2 curve was then superimposed upon the C. M. curve, thus enclosing an area indicative of the Bay losses, (Figure XIII-5). Next it was possible to utilize from Figure XIII-5 new slope corrections which were added to the C. M. curve (corrected for time and concentration). A visual comparison of the effect of the Bay losses is then apparent from Figure XIII-4. A tabulated comparison of the effects of the various corrections are shown in Table XIII-5.

To confirm the Test 8 results, corrections were made for Tests 3 and 6 after 60 and 80 tidal cycles. The results of these corrections are shown in Table XIII-6 as percent of dye accounted for.

E. Effect of Wetted Perimeter

Referring back to Table XI-4 of the Appendix, it may be noted that the correction factor grows increasingly larger from Tests 3 through 7, 6, 8, and 9. It may be assumed that this increasing loss is in part related to the increasingly larger wetted perimeter as we move downstream. The conditions under which the experiments were performed make it impossible to make a finite evaluation of the dye loss with respect to the change in the wetted perimeter area. It appears a detailed knowledge of not only the wetted perimeter in a

TABLE XIII - 4

DELAWARE RIVER MODEL TEST 8, (HWS)
DYE ACCOUNTED FOR, (PERCENT) AFTER CORRECTION
FOR TIME AND CONCENTRATION LOSSES

Cycles	Uncorrected	Corrected
20	66.29	65.96
40	67.84	74.98
60	64.63	74.18
80	58.89	70.14
100	53.20	65.44
120	48.90	61.53
140	42.87	57.61
160	41.61	54.23
180	38.72	51.47

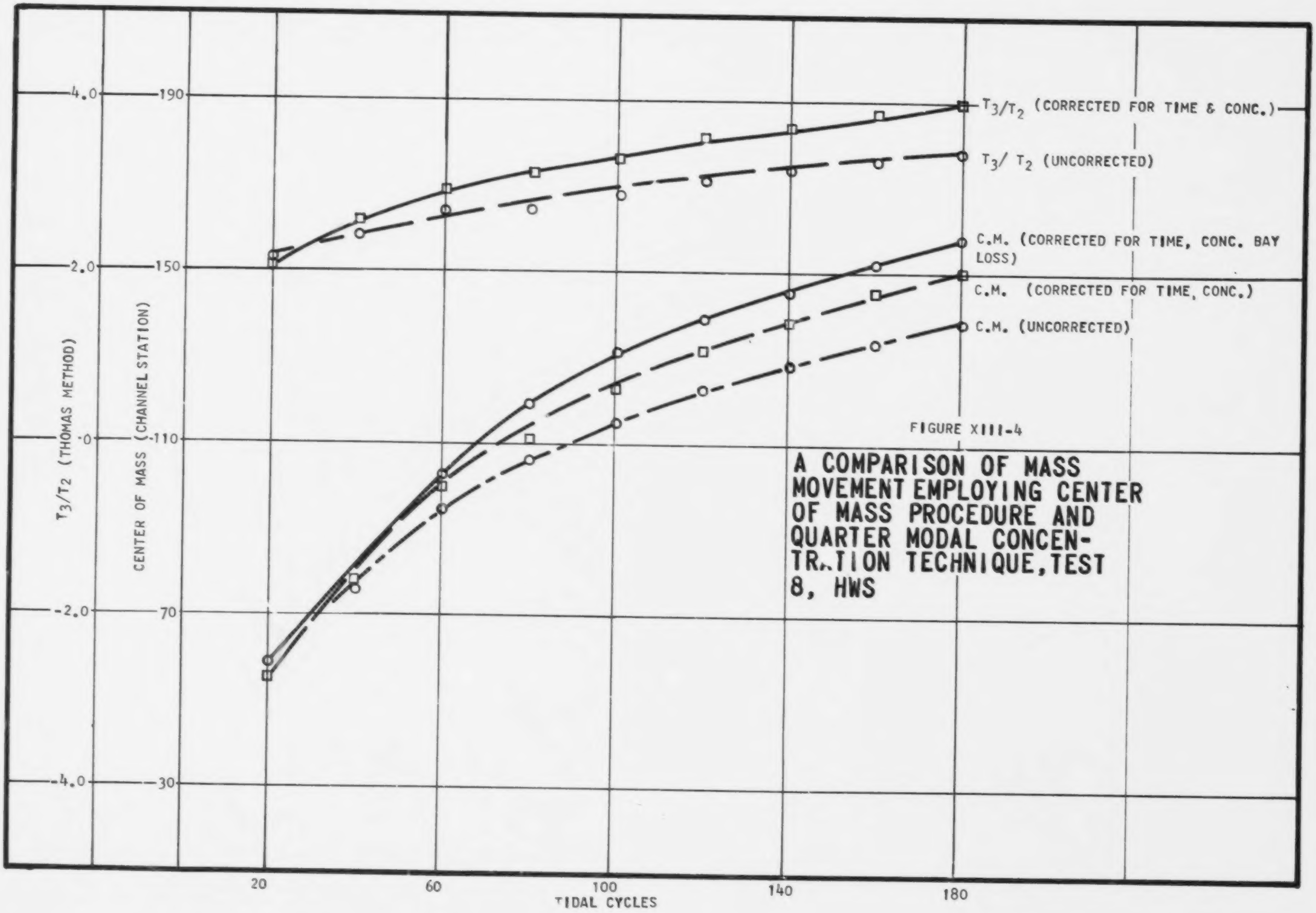


FIGURE XIII-4

A COMPARISON OF MASS MOVEMENT EMPLOYING CENTER OF MASS PROCEDURE AND QUARTER MODAL CONCENTRATION TECHNIQUE, TEST 8, HWS

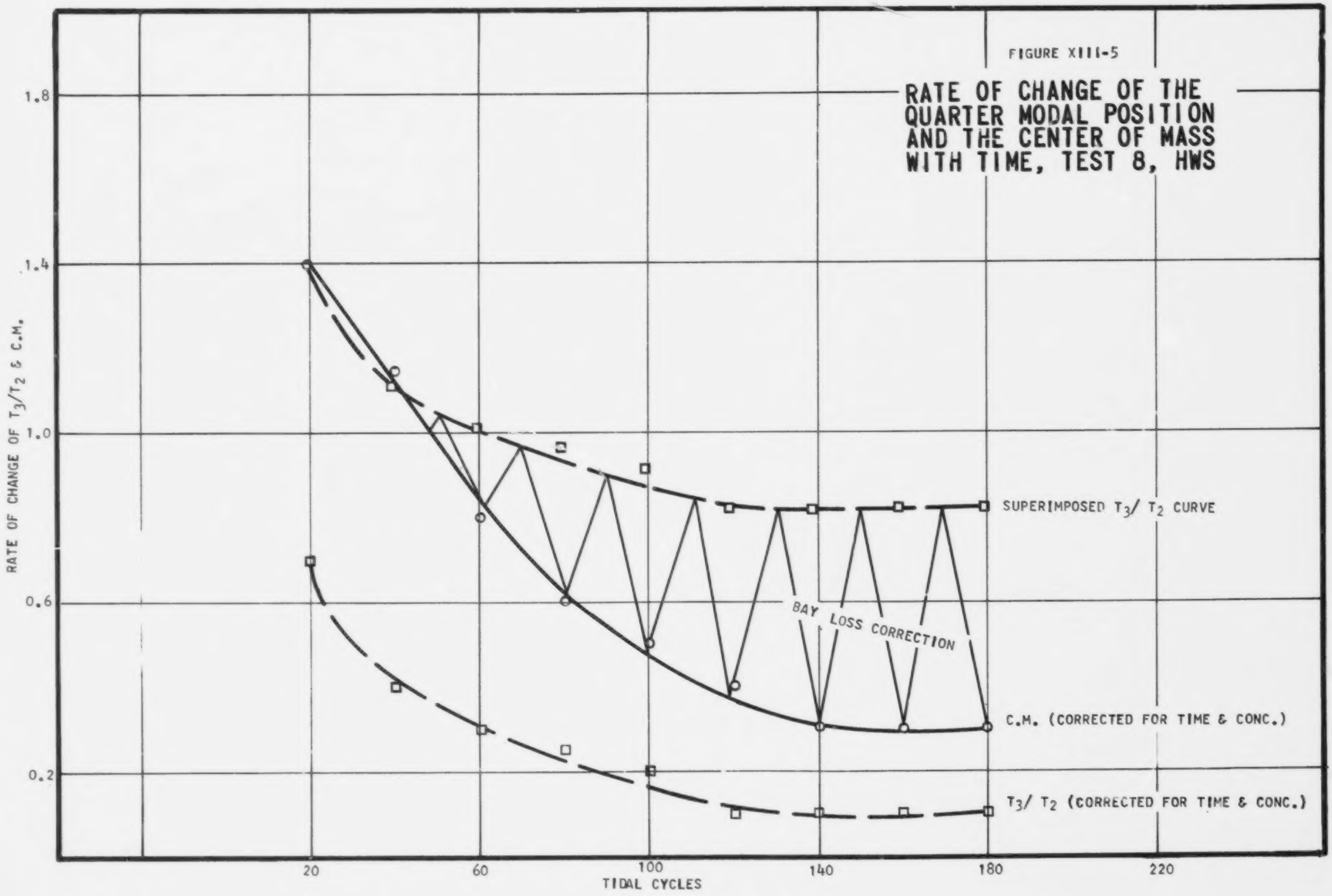


FIGURE XIII-5

RATE OF CHANGE OF THE QUARTER MODAL POSITION AND THE CENTER OF MASS WITH TIME, TEST 8, HWS

TABLE XIII - 5

DELAWARE RIVER MODEL TEST 8, (HWS)
CORRECTED CENTER OF DYE MASS LOCATION, (STA. LOCATION)

Cycles	Uncorrected* Location	Corrected** Location	Time, Conc., and Bay Loss Correction
20	58.87	55.01	-
40	75.97	78.68	-
60	94.36	98.56	103.0
80	106.24	112.41	119.0
100	115.66	122.25	131.0
120	122.70	131.39	139.0
140	128.42	138.59	145.5
160	133.91	144.54	151.5
180	138.71	150.21	157.5

* Data from Table XI-3
**Corrected for time and concentration but not Bay Loss

TABLE XIII - 6

DELAWARE RIVER MODEL TESTS 3, 6, (HWS)
DYE ACCOUNTED FOR AFTER CORRECTION FOR TIME AND CONCENTRATION

Cycles	Test 3 Corrected %	Test 6 Corrected %
60	80.08	71.74
80	76.76	71.83

specific location must be known, but the actual concentration of the dye overlying, plus the exact age of the dye at each point. However, a relative evaluation of the effect of wetted perimeter appears possible.

Since all the factors directly involved in dye loss, except the wetted perimeter, have been taken into consideration, it may be assumed that the increasing dye loss evident from the tests performed progressively downstream is due to the change in wetted perimeter. Further, since the quarter-modal procedure shows the relative relationship in a family of curves, and is not dependent upon the dye lost to the Bay area, a comparison of the wetted area between the quarter-modal points at equal intervals of time, would provide a parameter corresponding to the change in wetted perimeter as we move downstream. The summary of these comparative areas between the quarter-modal points for Incodel tests 3,7,6,8, and 9, are shown in Table XIII-7. Consequently, if this test series were corrected for time-concentration, age, Bay losses, and increased proportionally and progressively by a factor corresponding to the increased wetted perimeter, a full and complete dye loss correction would result.

It may be assumed that the amount of dye loss will increase as the dye is exposed to increasingly larger surfaces. This concept is supported by the relationship of values summarized in Table XIII-8. Incodel tests 3,6,7,8, and 9, show a progressively smaller percent of dye being accounted for, that is, dye loss is increasing with the increasing flow. However, the mass curves for this series show that the wetted area to which the dye is exposed increases progressively (Tests 3,6,7,8, and 9). The percent difference in wetted area between test 7 and tests 6,8, and 9, for each cycle period (Table XIII-9) was determined. An average difference was taken of the 60-cycle to

TABLE XIII - 7

DELAWARE RIVER MODEL TEST SERIES 3,7,6,8, & 9
(HWS) WETTED PERIMETER IN MODEL BETWEEN QUARTER MODAL POINTS

	AREA BETWEEN 1/4 M.C. POINTS, (cm^2)				
Cycles	Test 3	Test 7	Test 6	Test 8	Test 9
20	559,625	607,715	529,525	660,825	624,790
40	706,600	766,275	769,625	867,380	920,950
60	795,400	899,400	959,525	1,090,750	1,151,880
80	862,000	1,006,988	1,116,225	1,244,925	1,310,013
100	992,500	1,124,250	1,222,275	1,373,000	1,456,675
120	1,068,400	1,218,630	1,308,175	1,537,413	1,573,075
140	1,153,575	1,286,200	1,394,025	1,664,538	1,682,375
160	1,159,862	1,366,488	1,479,875	1,780,063	1,835,250
180	1,230.925	1,429,150	1,587,025	1,848,113	1,928,450

TABLE XIII - 8

DELAWARE RIVER MODEL TEST SERIES 1-9, (HWS)
PERCENT DYE ACCOUNTED FOR (CORRECTED FOR TIME & CONCENTRATION)
(RECIPROCAL OF TABLE XIII - 1)

Test	CYCLES								
No.	20	40	60	80	100	120	140	160	180
1	83.24	70.94	67.43	64.03	61.46	57.97	54.84	52.98	52.06
2	87.13	78.19	71.81	67.52	62.47	57.24	54.27	50.99	48.67
3	68.67	71.54	69.70	66.26	61.26	57.91	53.32	50.10	47.76
4	66.46	63.50	58.35	53.59	48.65	43.22	39.55	36.58	34.05
5	71.47	64.23	56.43	50.81	45.50	41.33	37.62	34.71	32.53
3	68.67	71.54	69.70	66.26	61.26	57.91	53.32	50.10	47.76
7	79.76	75.85	73.24	67.88	63.15	57.59	54.55	50.99	47.78
6	74.31	70.25	64.63	59.35	54.08	49.22	45.62	42.40	39.85
8	66.29	67.84	64.63	58.89	53.20	48.90	42.87	41.61	38.72
9	63.66	64.78	59.02	53.30	48.20	43.90	40.08	36.91	34.08

TABLE XIII - 9

DELAWARE RIVER MODEL TESTS 7, 6, 8, & 9, (HWS)
PERCENT DIFFERENCE IN WETTED AREA BETWEEN TEST 7 AND TESTS 6, 8, & 9

Cycles	Test 6	Test 8	Test 9
20	-12.87	+8.74	2.81
40	+ 0.44	13.19	20.19
60	6.69	21.28	28.07
80	10.85	23.63	30.09
100	8.72	22.13	29.57
120	7.35	26.16	29.09
140	8.38	29.42	30.80
160	8.30	30.27	34.30
180	11.05	29.32	34.94
Average 60-180	8.76	26.03	30.98

180-cycle values. The areas noted make use of the wetted perimeters between the points of 1/4 modal concentration (Table XIII-7).

It is assumed that there is a direct relationship between wetted area and dye loss, that is, a unit percent increase in area will cause a corresponding unit percent increase in the mass of dye lost.

The loss in Incodel Test 7 was taken as a unit dye loss. There was an 8.76% average increase (Table XIII-9) in area from Test 7 to Test 6. The dye loss in Test 6 should, therefore, be 1.0876 times the loss in Test 7. The percent of dye accounted for in Test 6 can now be corrected for relative area-change as follows:

Let X = mass of dye lost in test 7.

A = total dye added in any test since equal amounts were added to all tests. The percent of dye accounted for in test 7 will be:

$$\frac{A - X}{A}(100) \qquad (1)$$

Since the loss in test 6 is theoretically 1.0876 times the loss in test 7 (or 1.0876 X), the percent of dye accounted for in test 6 will be:

$$\frac{A - 1.0876\,X}{A}(100) \qquad (2)$$

The difference between (1) and (2) is:

$$\left[\frac{A - X}{A} - \left(\frac{A - 1.0876\,X}{A}\right)\right] 100 \qquad (3)$$

Equation (3) represents the percent of dye accounted for in test 7, minus the percent accounted for in test 6. This expression can be reduced to:

$$\frac{0.0876\,X}{A}\quad(100) \qquad (4)$$

The value X/A is the fraction of dye lost or unaccounted for in test 7, and is equal to 1.0 minus the percent of dye accounted for in the test. Equation (4) can now be written: (5)

$$(\%\text{ Acct. for in test 7}) - (\%\text{ Acct. for in test 6}) = \Big[(0.0876)\,(1 - \%\text{ Acct. for in test 7})\Big]$$

Thus:

$$\frac{\%\text{ Acct. for in test 6} + 8.76}{1.0876} = \%\text{ Acct. for in test 7} \qquad (6)$$

If the only factor involved in the dye loss was wetted area, then values from Table XIII-8 for test 6 could be substituted into equation (6) to actually produce the percent of dye accounted for in test 7, shown in Table XIII-8. Since the varying area has been eliminated, the values in Table XIII-8 would be the same for all tests. Area is not a single factor, however, and therefore, the values produced by equation (6) do not actually equal the percent of dye accounted for in Test 7, but they are the percent of dye accounted for in Test 6 corrected for area relative to Test 7.

Similar equations can be developed for Tests 8 and 9. Table XIII-9 shows the percent difference in area between Tests 7 and 8 to be 26.03. Thus:

$$\frac{\%\ \text{Acct. for in Test 8} + 26.03}{1.2603} =$$

% Acct. for in Test 8 corrected for relative area (7)

And similarly:

$$\frac{\%\ \text{Acct. for in Test 9} + 30.98}{1.3098} =$$

% Accounted for in Test 9 corrected for relative area (8)

These three formulae have been applied to tests 6, 8, and 9, and a summary of the corrected percentage is given in Table XIII-10. It may be noted that there is no longer a significant variation between each test when the wetted area has been reduced to a "constant". The slight spread which does exist can be attributed to the other variables.

The time-concentration-age correction will not change the overall conclusions drawn. As an example, the corrected and uncorrected Test 8 (HWS), after 180 cycles, is shown in Figure XIII-6. It should be noted that this corrected Test 8 does not include the loss due to increased wetted perimeter, however, to make the point, this inclusion does not appear necessary. A more significant comparison with respect to the effect of dye loss correction is given by the ultimate concentration values. It may be recalled from previous presentations that when the uncorrected ultimate L (buildup) values for each station were plotted on semilog paper, they not only form a straight line, but Tests 3, 7, 6, 8, and 9, formed parallel curves. When the individual station buildup curves for Test 8 of corrected data are placed in the analog computer, as was the uncorrected data, the resultant ultimate L value will be of greater magnitude. However, it appears evident a straight line curve will be formed again for the ultimate L values and that the parallelism between the various experiments still exists.

TABLE XIII - 10

DELAWARE RIVER MODEL TESTS 7, 6, 8, & 9 (HWS)
PERCENT OF DYE ACCOUNTED FOR AFTER RELATIVE AREA CORRECTION**

Test No.	CYCLES 20	40	60	80	100	120	140	160	180
7	79.76	75.85	73.24	67.88	63.15	57.59	54.55	50.99	47.78
6	*	*	67.48	62.62	57.78	53.31	50.00	47.04	44.69
8	*	*	71.94	67.38	62.87	59.45	54.67	53.67	51.38
9	*	*	68.71	64.35	60.45	57.17	54.25	51.83	49.67

*No corrections made for these cycles since areas involved during initial periods of dye buildup are inconsistent, possibly due to influence of eddying action within the dock areas in and about the dye release point.

Sample calculation:

Using Eqn. (7)

$$\%\ \text{Acct. for in Test 8} = \frac{64.63 + 26.03}{1.2603} = 71.94\%$$

(for 60 cycles)

**Corrections applied to Data shown in Table XIII - 8.

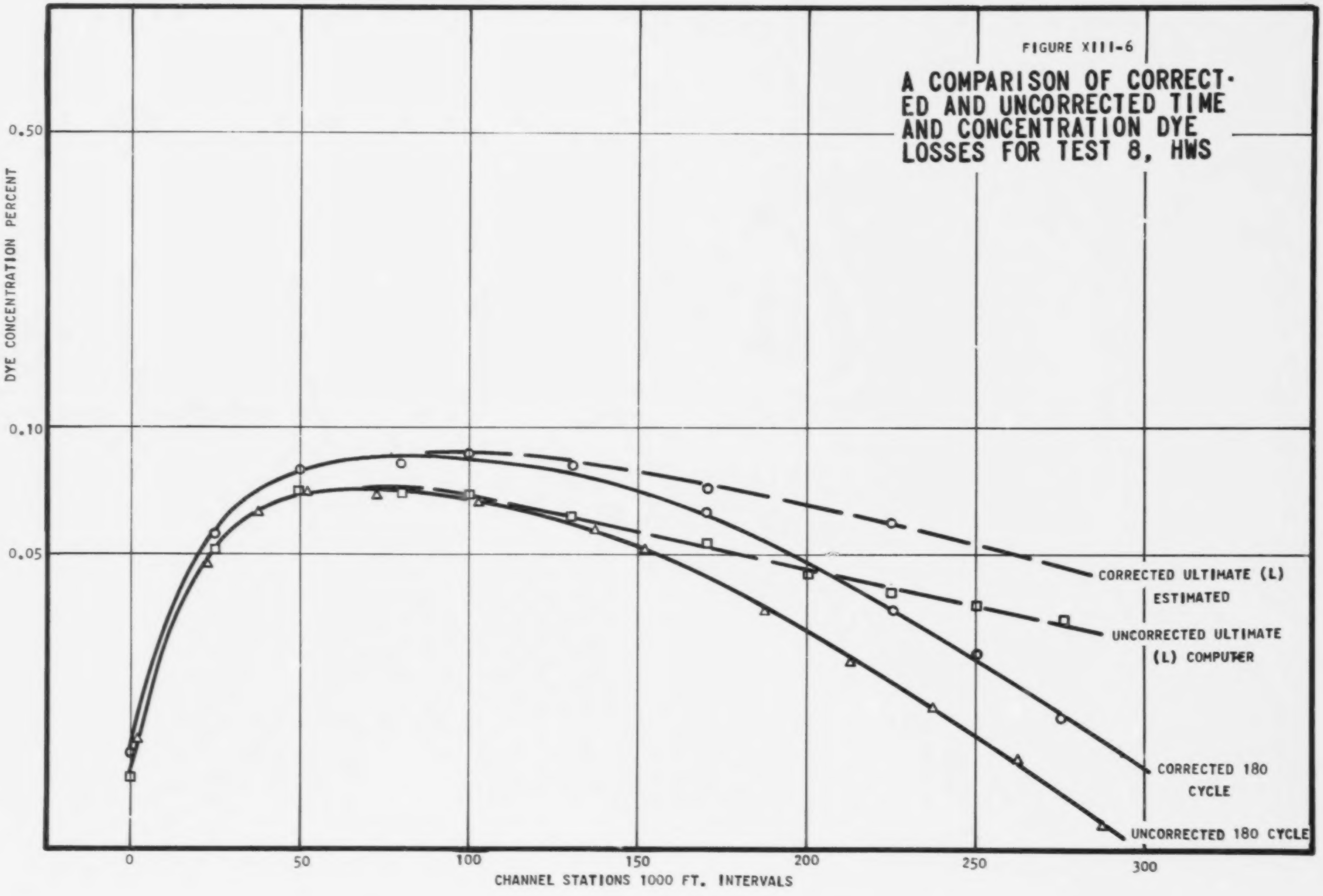


FIGURE XIII-6

A COMPARISON OF CORRECTED AND UNCORRECTED TIME AND CONCENTRATION DYE LOSSES FOR TEST 8, HWS

PART II

POTENTIAL APPLICATIONS OF MODEL STUDY FINDINGS TOWARD PURIFICATION CAPACITY EVALUATIONS

CHAPTER XIV

ASPECTS OF ESTUARINE PURIFICATION CAPACITY

Part II of this report will serve as a bridge between the analytical data from the Vicksburg Model and its potential application as a working tool toward pollution abatement. In view of this, a review of the basic principals and specific aspects of estuarine problems is in order.

A. General

1. Causes of Tides

Tides are produced (16) by the differential gravitational action of the sun and moon, the moon having the greater effect because of its relative nearness to the earth. In the sea, the tide rises twice in a lunar day of 24-hours and 50 minutes. Thus, in general, there are two high tides and two low tides each calendar day. At new and full moon, the sun and moon are acting in the same direction, and the difference between high and low tide is greatest. This is known as spring tide. When the moon is in the first or third quarter the range is less than average. This is neap tide. The moon's orbit about the earth is elliptical. When the moon is nearest the earth (in perigee) the tidal range is greater than when the moon is farthest from the earth (in apogee). Other variations in the tidal range arise from the fact that the orbit of the moon about the earth is not in the earth's equatorial plane. The two daily high tides are most nearly equal when the moon is over the equator, and differ the most when the north or south declination of the moon is greatest. These are known as the high-high tide and the low-high tide. An equivalent statement can be made of the two daily low tides, called the high-low tide and the low-low tide. On the Atlantic Coast there are two high waters and two low waters in a lunar day (semidiurnal tides). The inequality between the two daily high tides (or the two daily low tides) is least when the moon is over the equator and greatest when it is farthest north or south of the equator. Such astronomical data are found in almanacs and also in the "Tide Tables" and "Current Tables" issued by the U.S. Coast and Geodetic Survey.

In the open ocean the tidal range may be 2.5 to 3 feet, but when the tidal energy is concentrated in an estuary the tidal range tends to increase. In an estuary of constant width and depth, the tides would be smaller at upstream points because of the frictional dissipation of energy. Most estuaries, however, decrease in width upstream and the tidal energy is concentrated in a smaller volume so that the tidal range usually increases upstream in spite of frictional losses.

Since time is required for the tidal oscillation to travel along an estuary or river, the time of high tide (or low tide) will vary along the waterway.

The shape of the waterway, its depth and width, irregularities or obstructions in the river bed or shoreline, all affect the tidal behavior of a waterway. Consequently, two connecting river channels may not undergo the same tidal conditions at the same time.

Widening, deepening, or straightening of a river channel may alter the tidal regimen as observed by Wicker and Rosenzweig (18) for the Delaware River at Philadelphia, about 100 miles from the ocean entrance.

One cannot exactly predict the actual tides, especially in the upper region of rivers subject to freshet conditions or in shallow bays with a small tidal range. An onshore wind which blows water into the bay may cause earlier and higher tides than predicted, while an offshore wind may result in tides later and at less heights than predicted. From 90 to 95 percent of the tides occur within 15 minutes of the predicted times.

2. Tidal Currents

Accompanying the vertical rise and fall of the tides is a periodic change in the direction and strength of the horizontal motion of water or current. The upstream flow is called the flood current, the downstream flow is the ebb current. Slack-water occurs when there is no horizontal motion of the water at the surface, high slack-water when the flood current stops and the ebb current is about to begin, low slack-water after the ebb but before the flood. The time of slack-water usually does not occur at high or low tide, and its relation to the times of high or low waters varies with the place. When the river discharge is low "slack-water will work upstream", i.e. it occurs later after high tide. The difference between the time at which slack-water occurs and the times of high or low tide may be as great as 1 to 3 hours.

3. Horizontal and Vertical Patterns

The data collected by the Delaware Water Pollution Commission during the summer of 1956, in a cross-sectional manner, has been discussed by Kaplovsky (17). At that time it was strongly evident that the channel itself was the controlling influence of sanitary quality, generally speaking, at any given cross-section. It was also evident that a series of the ship channel samples would be representative, pollution-wise, of the river at that location. Further work indicated that the cross-section sampling volume could be reduced in certain areas from 3 to 1 sample in the ship channel.

The results presented in the Water Pollution Commission's (State of Delaware) Technical Report II, (17) validate the theory that the channel waters are reasonably uniform horizontally; that is, surfaces, mid-depth and bottom level water quality can be established within reasonable limits by sampling the respective ship channel levels. It is well understood, however, that the water quality will change from the surface to the bottom, and in deeper estuaries this difference can be most significant.

Compared to the other river estuaries, the Delaware River is a comparatively shallow body of water and, coupled with other configuration features, provides a non-stratified system. Because of the similarities at all levels, with small concentration differences, surface sampling is, within reasonable limits, representative of the average compositions vertically.

4. "Same-Slack" Procedure

In any investigation of water movement within an estuary, indiscriminate sampling only results in data which, for all practical purposes, becomes "indeterminate" unless a great number of measurements are made and the findings are delineated in accordance with each variable. In view of the numerous variables existing within an estuary, it is deemed prudent to keep these variables at a minimum. It becomes of paramount importance, therefore, to limit all sampling to either high or low water-slack periods. Technical Report II, (17) by the Water Pollution Commission of the State of Delaware, shows how a timed "same-slack" sampling procedure was not only feasible but far more accurate than the longitudinal comparison of the cross-sectional technique.

B. Oxygen Balance

1. Introduction

It is reasonably well accepted that a relationship exists between oxygen resources and oxygen demanding material in any stream. Degradation of organic matter, chemical oxygen demand, and to a minor extent, the respiratory processes of plants and animals, represent the oxygen demanding aspects. Certain oxygen resources can be evaluated at any given moment, however, others are progressively accumulated. The demands are progressive also and may be stated only in terms of ultimate demands or of demands over a given interval of time. Oxygen resources within a given stream are chiefly derived from reaeration, photosynthetic activity, and/or dilution (accrual) water from tributaries to any stream under investigation. The biochemical degradation of organic material (21)occurs at a rather low velocity and has temperature coefficients which cause the demands to be exerted at increasing velocity and up to somewhat greater amounts at higher temperatures. Consequently, any such oxygen balance must be a time and temperature function. Therefore, oxygen resources and pollutional loadings, coupled with time and temperature functions as affected by the numerous physical variabilities associated with a stream, must be properly orientated and inter-related in order to arrive at an understanding of resultant stream quality and/or stabilization of organic matter.

A few of the physical factors which may influence the ultimate quality of a river system, such as the Delaware River Estuary, are rate of flow, diffusitivity, vertical mixing, horizontal dispersion, tide, wind, weather, waste location, and configuration of the river itself. Secondary influences such as benthal demand, color, and turbidity (which may influence the degree of photosynthetic activity) may also become prime factors.

The evaluation of the self-purification capacity of the Delaware River Estuary may be divided into two broad phases, namely, dispersion, and biochemical activity. The factors affecting dispersion such as rate of flow, tidal action, wind conditions, mixing, diffusitivity, and river configuration, were covered in some detail in previous sections. The aspects relating to the biochemical activity such as oxygen resources, time, temperature, and pollutional loadings, need further comment. The impact of dilution water oxygen is significant in the upstream and downstream reach of the Delaware Estuary. Upstream, high D.O. water could represent a major source of oxygen and higher D.O. Bay water emphasizes its presence in a similar manner downstream. Areas intermediate, primarily due to smaller tributary flow with regard to the size of the receiving body of water, are less affected by accrual oxygen water. It has been estimated for other river basins that as much as one-third of the total exygen resource in upstream areas is contributed through tributary flow.

2. Accrual Oxygen

A river system will receive its oxygen predominantly from its tributary flow, photosynthetic activity, and reaeration. In an upper reach of the Delaware River estuary, accrual oxygen has been approximated at 16.3% of the total supply per day (see discussion).

3. Photosynthesis

There are two major sources of oxygen in natural waters, direct solution from the atmosphere, and solution due to photosynthetic activity. In general, with regard to the latter, there exists a wide variance as to the amount of oxygen supplied from chlorophyll bearing plants. Many studies have been performed on this aspect where the contributions varied from zero oxygen to as much as 2.65 g/m^2/d.

One of the more historic studies, made on the Potomac River area by Purdy (24), gives estimates of the magnitude of reaeration of streams through the activities of plant life. This study covered the Hunting Creek Flat, located downstream from the waste discharges of Alexandria, Virginia. It was observed that not only was the waste load satisfied without a loss of oxygen, but a distinct net gain was measured due to the activities of the micro-organisms. Dissolved oxygen values were as high as 128% of saturation. Purdy estimated that there are some 10 sq. miles of flats between Washington and Marshall Hall, for approximately 12 miles downstream. The volume of water flowing from these flats into the main channel of the river each day is equivalent to something over 14,000 cu. ft. per second. After passing through the dense plant growth and being diluted with the residual highly oxygenated waters left from the previous tide, the waters again entered the main channel, clarified and reaerated, even to supersaturation.

Another interesting study was conducted on the White River in Indiana (3). This was an example of photosynthesis in which reaeration for 7.5 hours, and water flowing swiftly over shallow ripples, was insufficient to suppiy the demand and prevent nuisance, while the additional oxygen produced by green plants brought the oxygen level back from a low of 1 ppm to approximately 6 ppm during the hours of sunlight. Quantitatively, the oxygen produced amounted to an average of 3 ppm over a 10-hour day. At a stream flow of 140 cfs, 945 lbs. of oxygen per day were produced which was sufficient to satisfy the demand of untreated sewage of 17,000 people during a flow period of 30 hours.

Garland (14), in his study of water quality in Baltimore Harbor, made some very noteworthy observations with regard to photosynthetic activity. In summarizing the various oxygen resources, Garland reported dissolved oxygen per day from new dilution water as 150,000 lbs.; reaeration 185,000 lbs.; and photosynthesis 400,000 lbs. It was interesting to observe that photosynthesis ranged from 10.3 to 12.6 ft. below the water surface, and averaged about 11 ft. It was further reported that, "The availability of oxygen is a matter for speculation. Surface water supersaturation was encountered frequently in the estuary during the daytime. Under such conditions the dissolved oxygen tends to be lost to the atmosphere. The estimated value of 600,000 lbs. per day probably represents an upper limit for oxygen derived from photosynthesis during clear summer weather."

Photosynthetic activity in the Delaware River Estuary could conceivably be considerably less than on the Potomac and/or of the Baltimore Harbor area. In all probability, many years ago, the extent of tidal flats and marsh areas in the Delaware Basin were not too different than those found on the Potomac or in the Chesapeake Bay area. Extensive growth and development in the Delaware River Basin during the past 200 or more years, involving drainage of wetlands and during the past 50 to 60 years extensive dredgings of the river with disposal on low land, has removed much of the potential areas of photosynthetic activity, as is now being experienced in the basins to the south. There still exist wetlands in Rancocas Creek area and north to Trenton, and from the prototype studies of the Delaware River, supersaturated conditions are occasionally experienced in this upper reach.

In comparison to the Baltimore Harbor area, the much higher flow within the Delaware River, different configuration and much greater tide change, result in marked differences in salinity content and the fresh to salt water ratio. Actually, the Delaware River Estuary has salinity levels which only are comparable to the uppermost portion of the Baltimore Harbor, and in general, similarity is remote. Further, the Delaware River, even though the depths are similar to the Chesapeake Bay, shows complete mixing from top to bottom with very little stratification, whereas, as far upstream as the Baltimore Harbor, sharp stratification levels are evident. In addition, water quality is considerably more depressed in the Delaware River Estuary if compared on the basis of the Baltimore Harbor study work of Garland (14). The stream banks are more sharply defined in the Delaware Basin and, "in toto", there is markedly less influence from flats and wetlands which are a prime conducents to high photosynthetic activity. However the above comparison, or relative degree of oxygen derived from chlorophylic plants, is a matter of judgement, and to some extent, speculative, which certainly warrants further study of this aspect with regard to the Delaware River Estuary.

An indirect measure of photosynthetic activity may be possible within the Delaware River Basin. Since a complete ultimate B.O.D. inventory of all waste discharges is underway, the ultimate oxygen demand from these discharges will be reasonably well established. A large portion of this estuary is well below saturation. The extent of reaeration can be reasonably well estimated and coupled with the oxygen resource from dilution, and compared to the total pollutional oxygen demand, would in essence provide an estimated balance of oxygen needed to stabilize fully the pollutional loadings within the Delaware River Estuary. This balance of dissolved oxygen would be a rough measure of the contribution made by photosynthetic activity. It should be remembered that this would only represent a rough approximation, and that study work with regard to photosynthesis is still warranted.

In a recent report from the U.S. Fish and Wildlife Service (10), emphasis was placed upon marsh destruction of the Delaware River and drainage measures including hydraulic fill and channelization between Delaware City, Delaware and Trenton, New Jersey, during the past 200 years. These changes have had a direct bearing on the oxygen capability from photosynthetic action. The areas covered by this long period of growth activity represent essentially the entire Delaware River Estuary.

The light-dark bottle method for measuring gross primary production of the community (defined as the sum of the net plant production and community respiration during the daytime), has questionable applicability in flowing waters (20) because much of the community is benthic and heterogeneous rather than planktonic. Furthermore, any measurements made without the normal turbulent flow may be questioned on grounds that production is a function of current flow. The upstream-downstream measurement of oxygen, carbon dioxide, and other properties, may become the accepted method for the study of metabolism of flowing waters. Odum (20) suggests two methods whereby the gross primary production per day can be obtained.

The first procedure (Δ C-method) involves an oxygen change, expressed as the difference in the oxygen concentration between two successive cross-sections at corresponding times. The area under such a curve, (expressed in ppm - hrs.), and above the horizontal line drawn at the sunrise concentration, multiplied by the discharge F, (in M^3/hr), and divided by the area X in M^2 between stations, gives the gross primary production per day (P). Thus:

$$P \text{ day} = \frac{F}{X}\int_{t_1}^{t_2} (\Delta c - \Delta c)\, dt$$

$$= \frac{F}{X} \text{ (area under the diurnal } \Delta c \text{ curve),}$$

here t_1 and t_2 are times of sunrise and when the oxygen change is no longer evident. Appropriate conversion units appear in the calculations for total pounds of oxygen for each segment.

The second procedure (Δ q-method) utilizes the change in oxygen concentration per hour at only one cross-section. The area under such a curve and above the horizontal line through the sunrise concentration, gives a first approximation to the daily gross primary production per day.

4. Reaeration

Water, when just saturated with oxygen, is in equilibrium with the atmosphere. When part of this oxygen is utilized to stabilize a waste, the balance is upset and oxygen must be obtained to restore the equilibrium. As the oxygen deficit of the water becomes greater, the rate of reaeration increases proportionally. Thus, reaeration will proceed at twice the rate when the deficit is 20% of saturation, as when the deficit is 10%.

There are two processes which allow reaeration to occur. The first is surface solution where a very thin film of water, in contact with the atmosphere, becomes saturated with oxygen almost instantaneously. The second process is diffusion, whereby, dissolved substances tend to expand or diffuse from points of higher concentration into points of lower concentration. Oxygen from the saturated surface film is carried into the lower layers by diffusion, and only by these two processes, surface solution and subsurface diffusion, can atmospheric oxygen become dissolved within a body of water.

Phelps (21) has developed a formula containing a diffusion coefficient, which is dependent on temperature, effective depth, and time to determine reaeration. His relationship is stated as follows:

$$K = \frac{\pi^2}{4}\,\frac{aT}{(L)^2}$$

where: a = diffusion coefficient

T = the time between mixings (hours)

L = the effective depth (ft.)

Once K is calculated, it can then be used to determine the rate of reaeration that is approximated by the following formula.

$$\log R_o = 1.85 + 0.5 \log (K)$$

where:

R_o = rate of reaeration per mix
(% of oxygen deficit per day)

Table XIV-1 lists the results of these calculations for the daily reaeration rates. It would be difficult to establish an exact rate which would apply specifically to the Delaware River. However, from the literature, approximations can be obtained.

The coefficient (a) varies with temperature. Professor Velz, (21) who has made important practical applications of the diffusion formula, found that the coefficient was well represented by the following relation:

$$a_T = a_{20} \times 1.1^{(T-20)}$$

a_T and a_{20} being the coefficient at T° and 20° respectively.

The tabulated data in Table XIV-1 represent the various amounts of daily reaeration using the Phelps procedure, after considering various depths and temperatures. A sample calculation follows:

SAMPLE CALCULATION:

For L = 20', Temp = 26°C, T = 10 mix/hr.

$$a_T = a_{20} (1.1)^{T-20}$$

$$= 0.00153 (1.6)^{+6} = .00269$$

$$K = \frac{(3.14)^2 (.00269) (1)}{4 (20)^2 \quad (10)} = 1.665 \times 10^{-6}$$

$$\text{Log } R_o = 1.85 + .5 \log (K)$$

$$= 1.85 + .5 \log (1.665 \times 10^{-6})$$

$$= 2.96071$$

$$R_o = 0.09135 \ \%/\text{mix}$$

$$\text{or} \quad 21.53 \ \%/\text{day}$$

$$D_a = 100 - \frac{1.9}{8.2} (100) = 76.8\%$$

$$R' = 76.8\% (21.53) = 16.5\% \text{ Sat./day}$$

$$(16.5\%) (8.2 \text{ ppm}) = 1.35 \text{ ppm/day}$$

$$\text{Amt. Oxygen} = 8.34 (1.35) \text{ ppm/day} = 11.25 \text{ lb/mgd}$$

TABLE XIV-1

Daily Reaeration as a Percentage of 100% Oxygen Deficiency
(Phelps Diffusion Formula)

L (ft.)	Temp. (C°)	Sat. O_2 (ppm)	T (mixings/hr.)	D_a (%)	R_o (%) day	R' % Sat./day	ppm/ day	lb./ mgd
*20	26°	8.2	10	76.8	21.53	16.5	1.35	11.25
"	"	"	15	"	26.75	20.5	1.68	14.00
"	"	"	20	"	31.06	23.9	1.96	16.35
"	"	"	40	"	43.28	33.1	2.71	22.60
"	20°	9.2	5	73.3	11.66	92.5	8.50	70.80
"	"	"	10	"	16.49	131.0	12.10	100.50
"	"	"	20	"	23.38	185.0	17.00	141.50
30	26°	8.2	15	76.8	17.93	13.8	1.13	9.42
"	"	"	40	"	29.28	22.5	1.84	15.35
"	"	"	80	"	41.47	31.8	2.61	21.80
25	20°	9.2	5	79.3	9.36	7.4	0.68	5.67

*Used 1.9 ppm as average D.O. in above calculations

For lack of a satisfactory definition of mixing effects, Imhoff and Fair (15) present overall values for the rate of reaeration that have been observed in various waters. The following daily reaeration values appear as percentages of constant oxygen deficiencies:

Small ponds and backwaters	17.3%
Sluggish streams, large lakes, and impounding reservoirs	28.8%
Large streams of low velocity	40.3%

The succeeding Table XIV-2 lists the calculated oxygen deficiencies for various segments in the Delaware River followed by an application of the Imhoff and Fair percentages appearing above.

Therefore:

17.3% of total = 1,580,349 lbs. oxygen per day.

28.8% of total = 2,630,870 " " " "

40.3% of total = 3,681,392 " " " "

Using Phelp's Method (21) for the segment from Eddystone to Marcus Hook, the reaerated oxygen equals:

Vol. = 26,000 M.G. (M.W.S.)

for L = 20', T = $26^{o}C$

O_2 = (11.25) (26,000) = 293,000 lb/day (for only 10 mixes per hour)

Using Imhoff and Fair's Method (for the same segment) and a rate of 17.3% of the deficit, we have the following:

O_2 = 17.3% (2,459,119) = 425,000 lbs./day

Both applications represent rather sluggish systems which should not apply to the Delaware Estuary. A comparison of the two methods for oxygen deficit is favorable, depending upon the arbitrarily chosen rate constants. Thus, it is highly probable that the amount of oxygen added to the river due to reaeration alone on September 15, 1958, may have varied between 2.6 and 3.6 million lbs.

TABLE XIV - 2

OXYGEN DEFICIENCIES FOR VARIOUS RIVER SEGMENTS

Segment	Oxygen Deficit (lbs.)*
Reedy Island	591,867
Pea Patch Island	846,355
New Castle	821,251
Cherry Island	1,174,325
Marcus Hook	1,395,789
Eddystone	1,063,330
Paulsboro	809,785
Navy Yard	881,430
Ben. Franklin Bridge	618,103
Allegheny Avenue	384,574
Palmyra	219,864
Torresdale	195,180
Burlington Bridge	77,682
Florence	35,581
Fieldsboro	19,851
TOTAL	9,134,967 lbs.

*Data were calculated from HWS and LWS prototype study averages for 9/15/58.

CHAPTER XV

RELATIONSHIP OF DYE BUILDUP RATES AND CONCENTRATION AT VARIOUS LOCATIONS UNDER DIFFERENT CONDITIONS OF FLOW

The curves in Chapter X show a relationship between dye buildup rates ("k" values) and position in the river. The effect of flow on the "k" values is shown for several positions. Similar relationships are shown for ultimate concentrations (L values). It would be most advantageous to find equations which will describe these relationships. Once such equations are determined, dye buildup constants can be found for intermediate flows and locations, and for release points other than those employed in the experiments.

The formula which describes the slope of a Gompertz growth curve (10) has been found to fit the data for linear portion "k" values. This approach is conceivably one of many potential solutions. Time did not permit further consideration. The Gompertz Curve describes a series of values in which the growth increments of the logarithms are declining by a constant percentage. The lower curve, Figure XV-1, is such a curve. This asymptotic growth curve can be described by the formula:

where $Y_c = ma^{b^x}$

or $\log Y_c = \log m + (\log a)\, b^x$

Y_c = accumulated "k"

m = slope

a&b = Gompertz coefficients

x = equal station increments

To illustrate the application of the Gompertz curve to our problem, a plot of "k" values (for Test 8-HWS) vs. Station No. will be used (Figure XV-2). To obtain a Gompertz type series from these data, the curve was divided into intervals ten stations apart. (Table XV-1 of the Appendix). Starting with the "k" value at Station -50, the "k" at each interval from Figure XV-2 was added to form the series. This series is shown on Table XV-1 of the Appendix, under the column headed Y. The upper curve in Figure XV-1 is a plot of these values.

The data can now be adjusted to form a typical Gompertz curve. The method of evaluating the coefficients (m, a, and b) is best understood by following the example in Table XV-2, which shows the calculations of coefficients for the data of Test 8. Table XV-3 of the Appendix, shows how these coefficients are applied to obtain the corrected Y values (column headed $\Delta\ Y_c$). These values, when plotted, formed the Gompertz curve in Figure XV-2.

TABLE XV-2

CALCULATION OF GOMPERTZ COEFFICIENTS
TEST - 8 (H.W.S.)

$\Sigma_1 \log Y = 77.9413 - 90$

$\Sigma_2 \log Y = 84.4462 - 90$

$\Sigma_3 \log Y = 85.6090 - 90$

$$b^n = \frac{\Sigma_3 \log Y - \Sigma_2 \log Y}{\Sigma_2 \log Y - \Sigma_1 \log Y}$$

$$b^n = \frac{1.1623}{6.5049} = 0.17876$$

$\log b^n = 9.2520 - 10 = -0.7480$ (where n = 9)

$\log b = 0.08311 = 9.91689 - 10$

$b = 0.8260$

$$\log a = \Sigma_2 \log Y - \Sigma_1 \log Y \; \frac{b - 1}{(b^n - 1)^2}$$

$$= 6.5049 \frac{(0.1740)}{(0.6744)}$$

$\log a = 1.67078 = 8.32922 - 10$

$a = 0.02135$

$$\log m = \frac{1}{n}\left[\Sigma_1 \log Y - \left(\frac{b^n - 1}{b - 1}\right) \log a\right]$$

$$= \frac{1}{9}\left[-12.0587 - \left(\frac{-0.82124}{-0.1740}\right) -1.67078\right]$$

$\log m = 0.46367$

$m = 0.3440$

In the column headed $\Delta\ Y_c$ in Table XV-3 of the Appendix, are the "first difference" values of Test 8. These are obtained by subtracting from each Y_c value the preceding Y_c. It is evident from

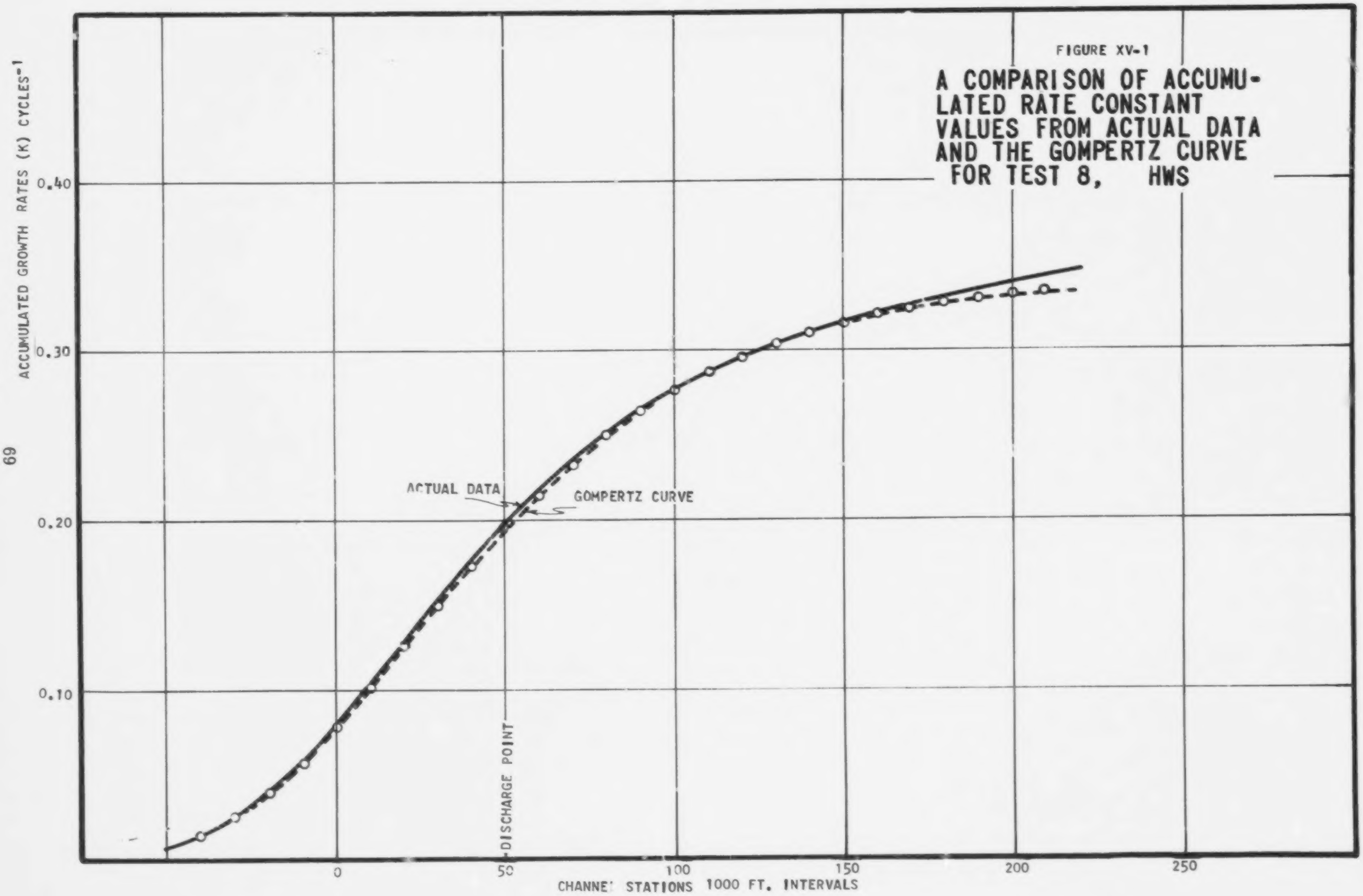


FIGURE XV-1

A COMPARISON OF ACCUMULATED RATE CONSTANT VALUES FROM ACTUAL DATA AND THE GOMPERTZ CURVE FOR TEST 8, HWS

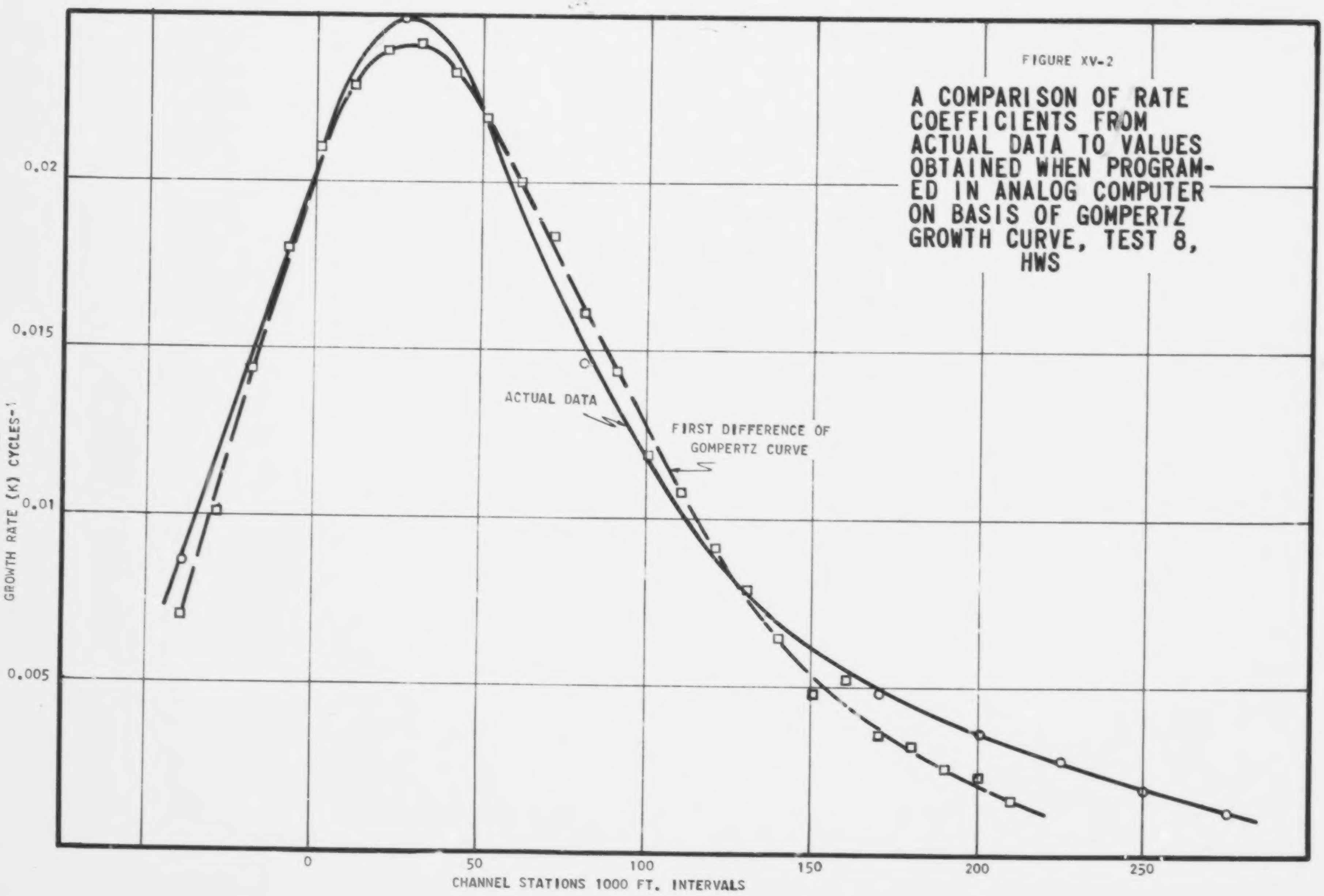


FIGURE XV-2

A COMPARISON OF RATE COEFFICIENTS FROM ACTUAL DATA TO VALUES OBTAINED WHEN PROGRAMED IN ANALOG COMPUTER ON BASIS OF GOMPERTZ GROWTH CURVE, TEST 8, HWS

Figure XV-2 that the calculated plot is a good fit of the actual data.

A first difference curve has also been made for the plot of "k" values versus Station for Test 7, (HWS), as an additional example (see Tables XV-4, XV-5, XV-6 of the Appendix and Figure XV-3). Now a comparison can be made as to how the coefficients will vary. The coefficients for the two tests are shown in Table XV-7.

Two sets of coefficients are not sufficient for comparison purposes and not at all suitable for interpolation to intermediate flow curves. (Test 7 was at a flow of 4,500 cfs, and Test 8, at 7,000 cfs.) It is necessary to have a complete set of "Gompertz" coefficients for this purpose. The procedure used for Tests 7 and 8, however, has several limitations. The most apparent is the time required for a single solution. This solution is based on an arbitrary selection of a starting point for the accumulation of values, and on finite increments of stations. These factors effect the "FIT" of the calculated curve.

Once again, as in the case of the unimolecular equation (Chapter X), the procedure is simplified by the utilization of an analog computor. The Gompertz formula is differentiated once to give the following expression for the slope:

$$\frac{dy}{dx} = yb^{x} \ln a \ln b$$

The slope is equivalent to the first-difference in the longhand procedure. Use of the computer allows coefficients to be adjusted rapidly to yield a curve of good fit by eye.

Coefficients have been determined for all "k" curves. These data appear in Table XV-8 of the Appendix. It should be noted that the coefficient "a" was held constant for all curves. With "ln a" equal to -1, the peak "k" value will always occur at $x = 0$. Examining the data in Table XV-8 of the Appendix, "ln b" appears to be nearly constant in all instances, "m" is the only coefficient which varies greatly. Figure XV-4 shows how "m" varies with varying release points. Figure XV-5 shows how "m" varies with flow. Further refinement of the data might establish a definite relationship between the "k" curves.

The same approach was considered advisable for the ultimate buildup levels derived from the model studies. The curves formed by plotting the buildup concentrations at progressive points did show some similarity with the Gompertz Curve. However, when programmed in the Computer the data did not fit the formula. This observation conceivably may be changed by improved dye loss correction procedures. This aspect should be pursued vigorously by other investigators as it appears highly probable a dispersion formula can be developed for concentration of conservative material. Time did not warrant investigating the matter further.

TABLE XV - 7

GOMPERTZ COEFFICIENTS
FOR "k" vs STATION CURVES FOR TESTS 7 AND 8

	b	log a	a	log m	m
Test 7	0.7960	-2.10950	0.00777	-0.78739	0.1633
Test 8	0.8260	-1.67078	0.02135	-0.46367	0.3440

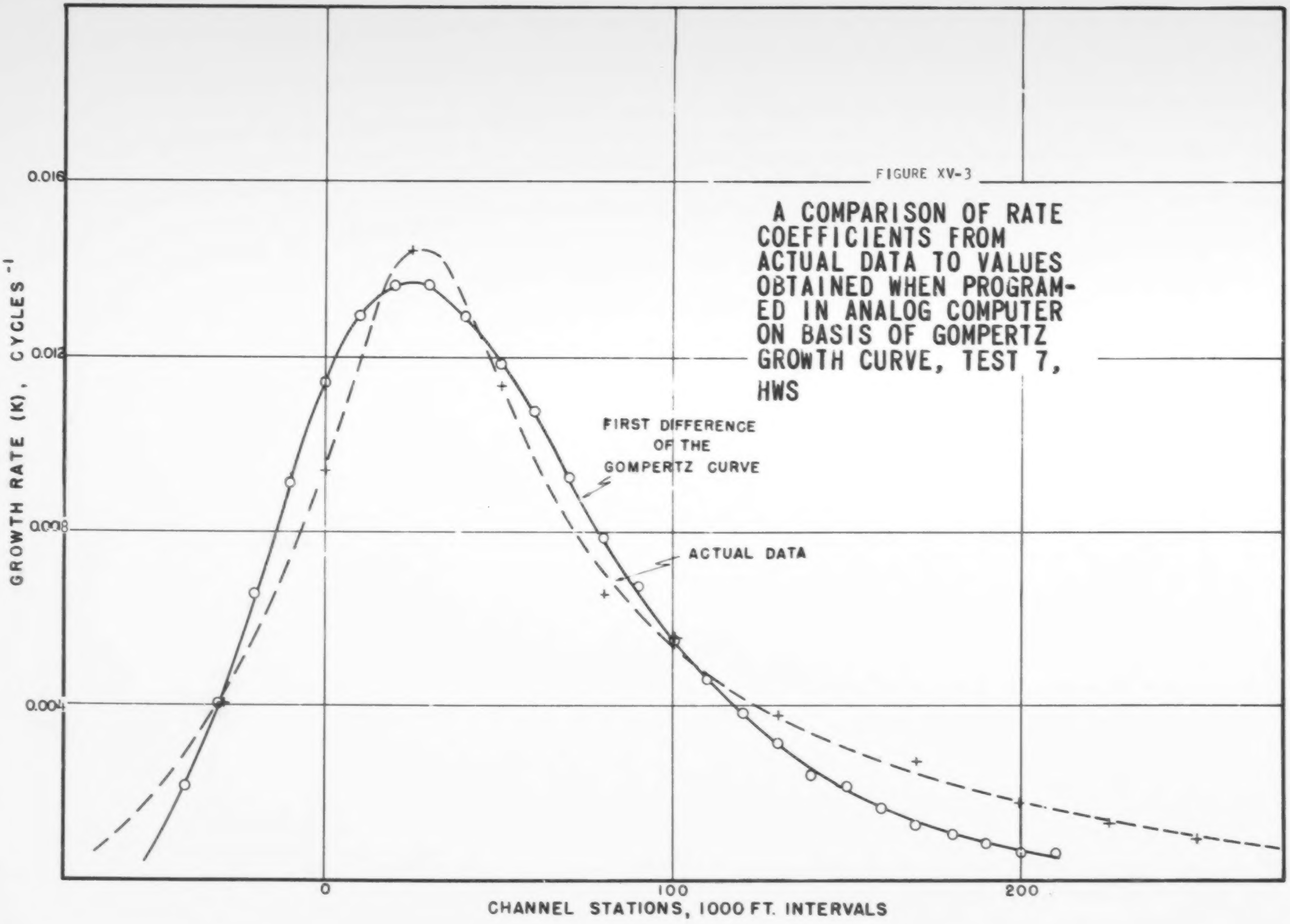


FIGURE XV-3

A COMPARISON OF RATE COEFFICIENTS FROM ACTUAL DATA TO VALUES OBTAINED WHEN PROGRAMED IN ANALOG COMPUTER ON BASIS OF GOMPERTZ GROWTH CURVE, TEST 7, HWS

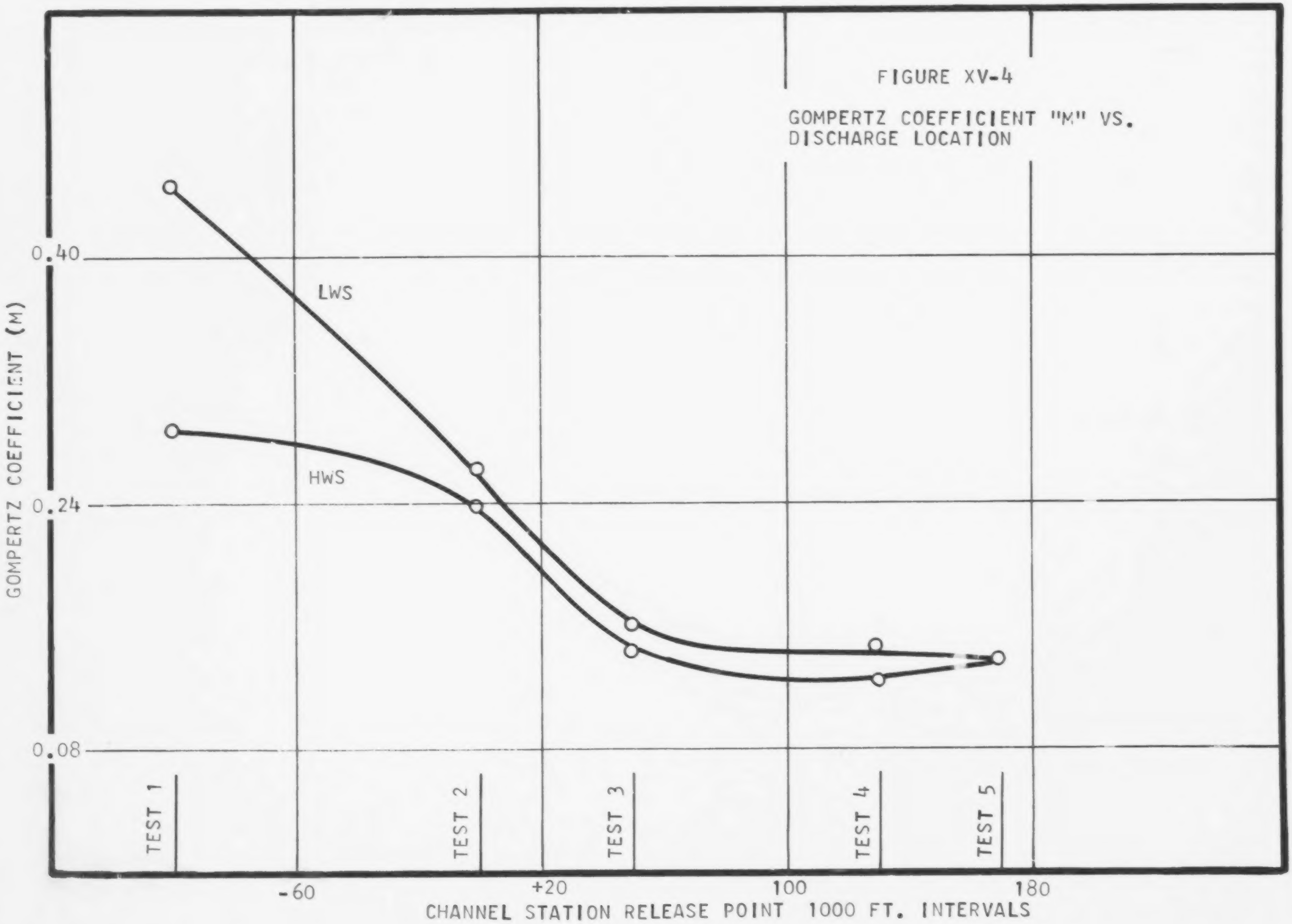


FIGURE XV-4

GOMPERTZ COEFFICIENT "M" VS.
DISCHARGE LOCATION

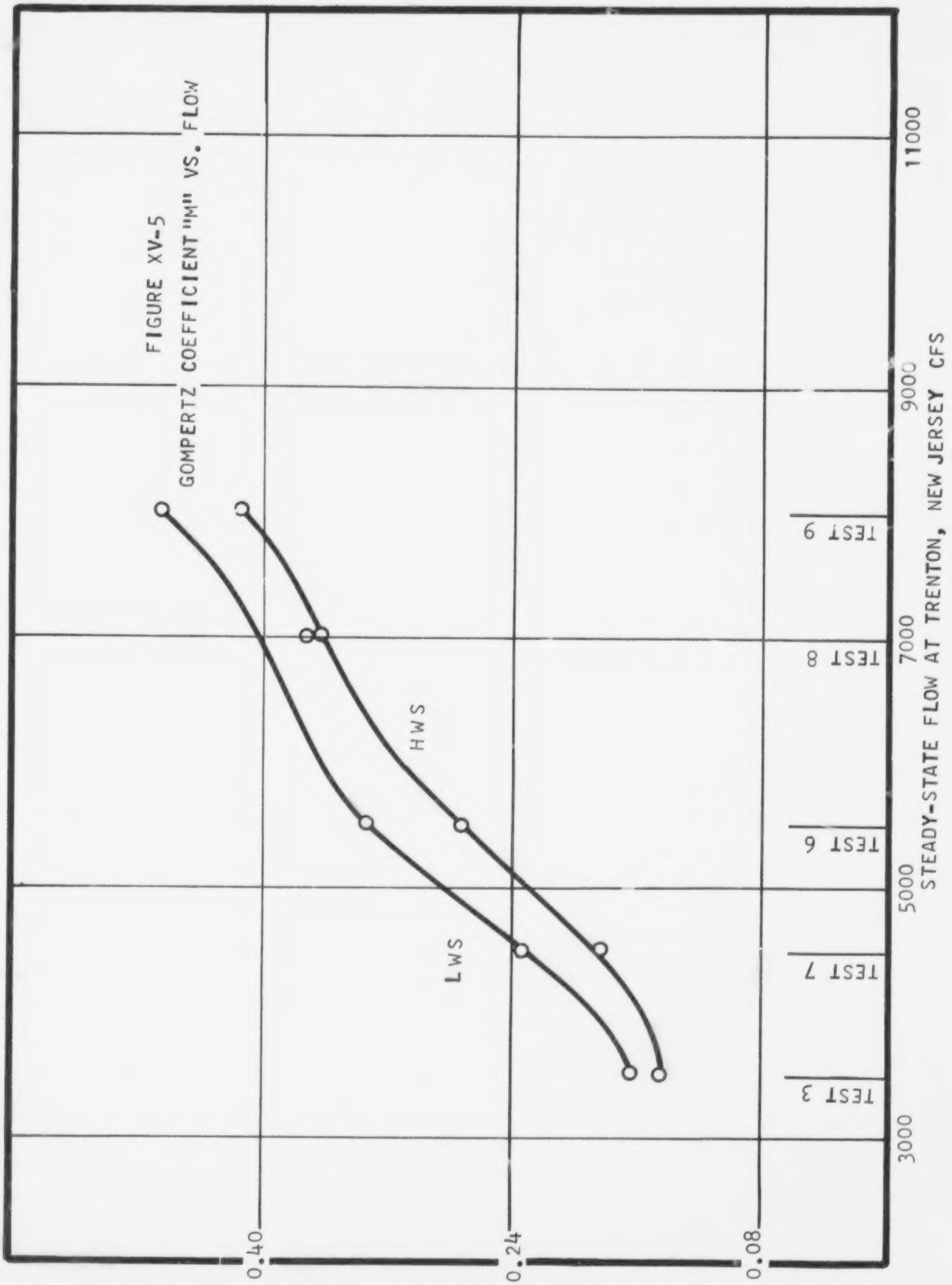


FIGURE XV-5
GOMPERTZ COEFFICIENT "M" VS. FLOW

CHAPTER XVI

EFFECT OF FLOW UPON THE STABILIZATION OF ORGANIC MATTER

In an attempt to simplify or generalize what takes place within a segment when a waste discharge enters the upper end, the following analogy appears valid. If the flow or transit time to pass through a segment is constant, it can be assumed a specific amount of stabilization of organic matter will take place as shown by the deoxygenation coefficient "k" at a given temperature. If "k" or the temperature should increase, the rate of stabilization will increase or visa-versa. It is equally true that should the flow increase, the time to traverse the segment under consideration would decrease with a corresponding decrease in time for stabilization. The latter would result in not only less stabilization of organic matter within the segment under consideration, but would project an increased loading into the downstream segment of heretofore stabilized organic matter. However, on the credit side, increased flow would result in decreased buildup concentrations. The question arises whether the loss of stabilization time within a segment induced by this increase in flow is sufficiently compensated by the lower buildup concentration level induced by this increase in flow. Incodel Tests 3, 6, 7, 8, and 9 were carried out with the same dye loading applied to the same location at progressively increasing flows. It appears reasonable that the effect of flow on organic stabilization could be demonstrated if the rate of deoxygenation and the decreasing buildup with increased flow could be compared under similar conditions.

Values from computer handling of Model Data (continuous dye releases) are presented in Tables X-1, through X-9 of the Appendix. These Tables show the velocity coefficient "k" resulting from dye buildup and also the ultimate concentration (L) at progressive station locations. Also shown is time lag before buildup commences. Four segments of equal length (30,000 ft.) are compared, namely, stations 50-80; 80-110; 110-140; and 140-170. The difference in concentration (Δ L) in segment 50-80 is taken from Figure XVI-1, and listed in Table XVI-1 of the Appendix. These data were plotted to obtain Figure XVI-2, and from this Figure the more accurate readings in Table XVI-2 of the Appendix were taken. The lower flow and ultimate L values, which do not appear in Figure XVI-2 were taken from Figure XVI-1.

In Figure XVI-3 are plotted the time of transit within each segment against flow. Time of transit values are taken from instantaneous release experiments of Incodel (Tests 10-14) and Waterways Experiment Station data. Data for the curves on Figure XVI-3 appear in Table XVI-3 of the Appendix. Transit times taken from the curves are listed in Table XVI-4 of the Appendix. If the change in buildup concentration (Δ L), Table XVI-2 of the Appendix, under any given flow, is plotted against the transit time to move through a segment at the same flow, Figure XVI-4 is obtained.

The variation of ultimate buildup (L) with flow is shown in Figure XVI-1. The variation of transit time with flow is shown in Figure XVI-3. The relationship between (Δ L) and time (T) at identical flow levels, is shown in Figure XVI-4. However, the ordinate values (Δ L) in Figure XVI-4 do not express the percent change in L which is needed to compare them directly with typical deoxygenation rate curves (Figure XVI-5).

If we were to assume the maximum (Δ L) in any segment were to occur under zero flow conditions, during which time organic matter was being added in the upstream end, we would, in essence, have the maximum concentration difference possible within this segment. Therefore, the curves shown in Figure XVI-1 were extended to a point of no flow and the resultant ultimate buildup values recorded at zero flow were assumed as the maximum L. Consequently, L can be shown as a percent of the ultimate at zero flow, and plotted vs. time for any given segment. Data for this plot are given in Table XVI-5 of the Appendix. Superimposing the deoxygenation rate curves (data in Table XVI-6 of the Appendix), expressed as percent organic matter stabilized vs. time (see Figure XVI-6), values could be found at any given flow which would show the amount of stabilization loss corresponding to the amount of decreased concentration buildup.

The effect of flow on stabilization can now be illustrated. From Figure XVI-6 we can determine the degree of stabilization, or the percent of the B.O.D. which will be satisfied within each 30,000 foot interval. This has been done at 500 cfs. flow intervals for all rates of stabilization ("k_1" values) indicated in Figure XVI-6. These values are listed in Tables XVI-7 to XVI-10 of the Appendix. These stabilization values must be combined with the decreases in concentration which will result from increases in flow. This is done by utilizing concentration values from Figure XVI-1, since this Figure shows actual concentrations which have resulted from model experiments. For the concentration or decomposable organic loading, which will be acted on, or stabilized within a segment of any flow, we have used the average concentration within the segment at that flow. This procedure allows for the normal concentration gradient (or drop in concentration across the interval) corresponding to increasing volume. These average concentrations, taken from Figure XVI-1, appear in Table XVI-11 of the Appendix. Now, in combining the two effects (changes in stabilization and concentration), we have derived what we have termed relative amounts of unstabilized organic matter. It expresses the relative amounts of undecomposed matter which remains in the system at the various flows. To obtain the relative amounts of unstabilized organic matter, the degree of stabilization (which is expressed in percent) is initially subtracted from one hundred. This results in the percent of unstabilized organic matter. These values are multiplied by the corresponding concentrations in Table XVI-11 of the Appendix.

The relative amounts of unstabilized organic matter for each segment are shown in Table XVI-12 through XVI-15 of the Appendix. They are listed for each flow and "k_1" value. An example calculation appears with Table XVI-12 of the Appendix. Table XVI-16 of the Appendix shows how the temperature and "k_1" values vary after using various assumptions for the velocity coefficient at 20°C.

The net increase or decrease of stabilized organic matter resulting from increased flow conditions at the various deoxygenation coefficients (20°C) is shown in Figures XVI-7 to XVI-13, in each of the segments considered. It is evident for example, in Figure XVI-9, that increasing flow is always beneficial in segment 50-80 and, although not as marked, in segment 80-110. However, in segments 110-140 and 140-170, a decrease in stabilization is evident up to a stream flow of 5,500 cfs. (Trenton) and thereafter additional flow increases are beneficial. It is also evident in the downstream stations that at flows as much as 8,000 cfs. did not result in a net stabilization as good as at 2,000 cfs. This general pattern will vary, however, with the deoxygenation rate "k_1" and/or temperature.

A typical example of the change resulting from different rates of deoxygenation and/or changes in temperature is also shown in Figures XVI-14 to XVI-17 for the various 30,000 foot station intervals. The following is evident:

a. At higher rates of deoxygenation the effect of increasing flow shows progressively poorer conditions.

b. At a constant "k_1" of 0.05 (20°C) decreasing temperatures comparable to late fall, winter, and early spring, conditions would result in essentially less change or improved conditions with increasing flow. (See Figure XVI-10).

After the completion of the calculations for this section, it was discovered that the dye in the experiments was at a concentration of 913 ppm. The concentration as originally reported was 1,000 ppm. All concentration values which are expressed as a percent of the initial concentration should be multiplied by the ratio of 1,000 to 913 to obtain correct values.

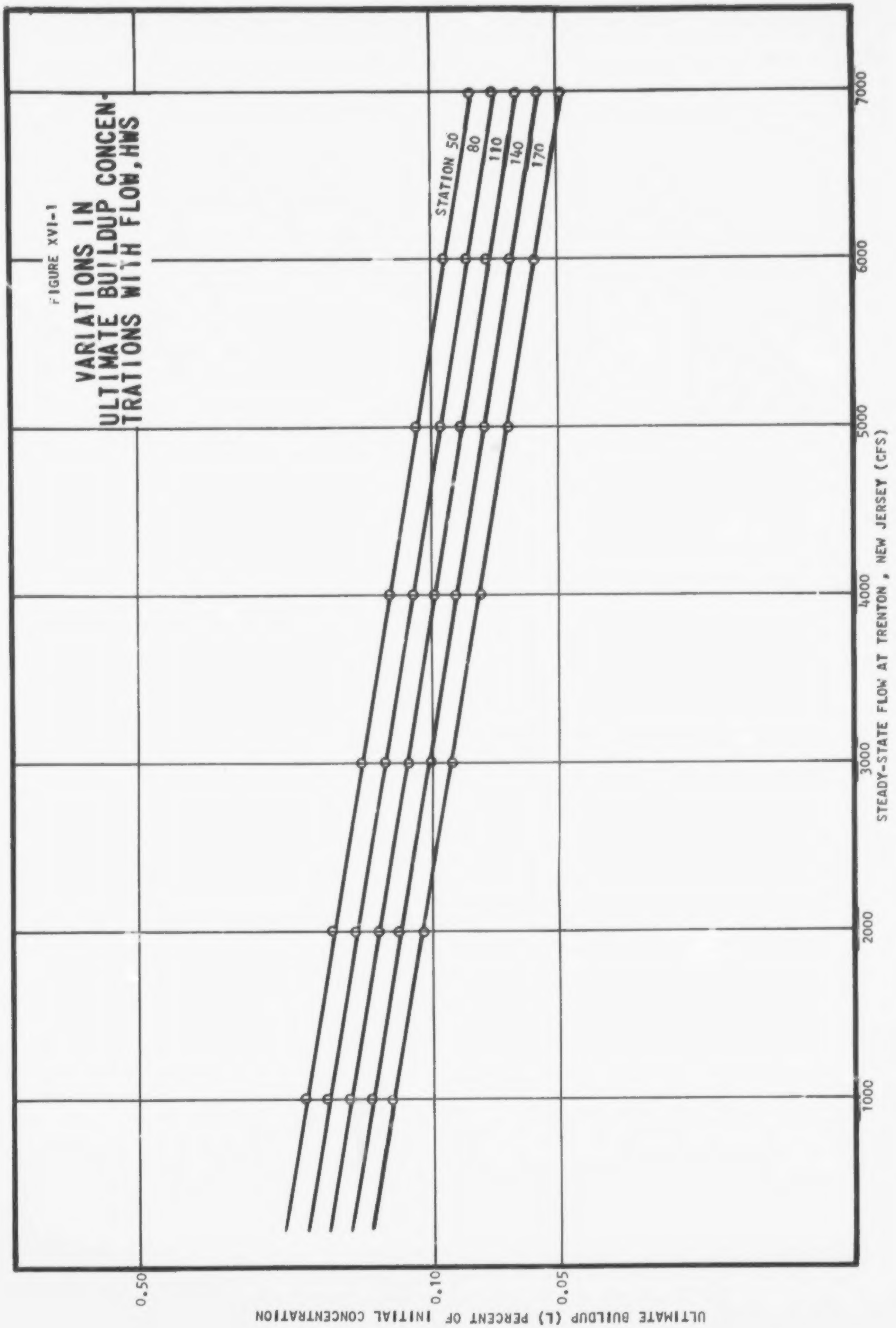


FIGURE XVI-1

VARIATIONS IN ULTIMATE BUILDUP CONCENTRATIONS WITH FLOW, HWS

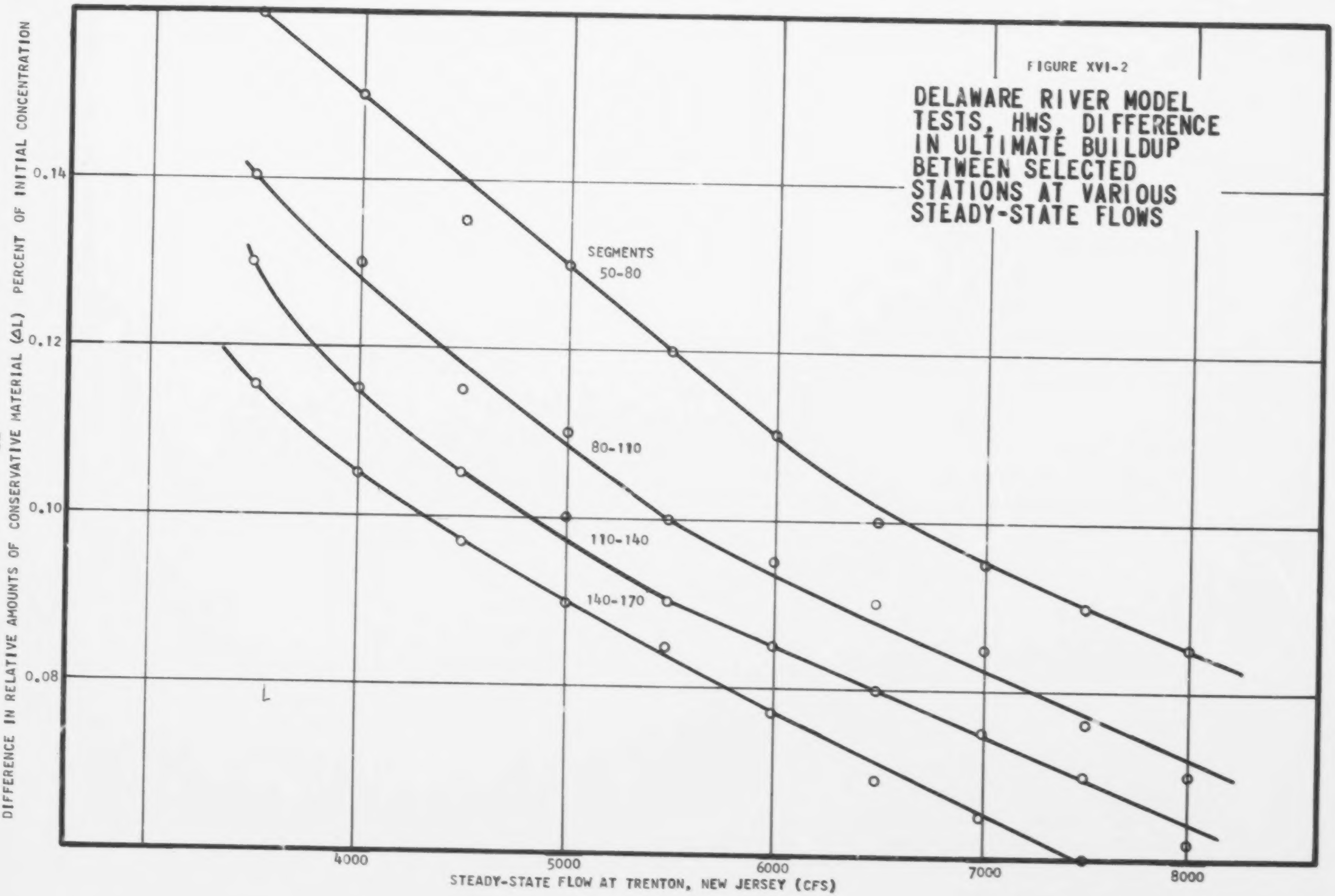


FIGURE XVI-2

DELAWARE RIVER MODEL TESTS, HWS, DIFFERENCE IN ULTIMATE BUILDUP BETWEEN SELECTED STATIONS AT VARIOUS STEADY-STATE FLOWS

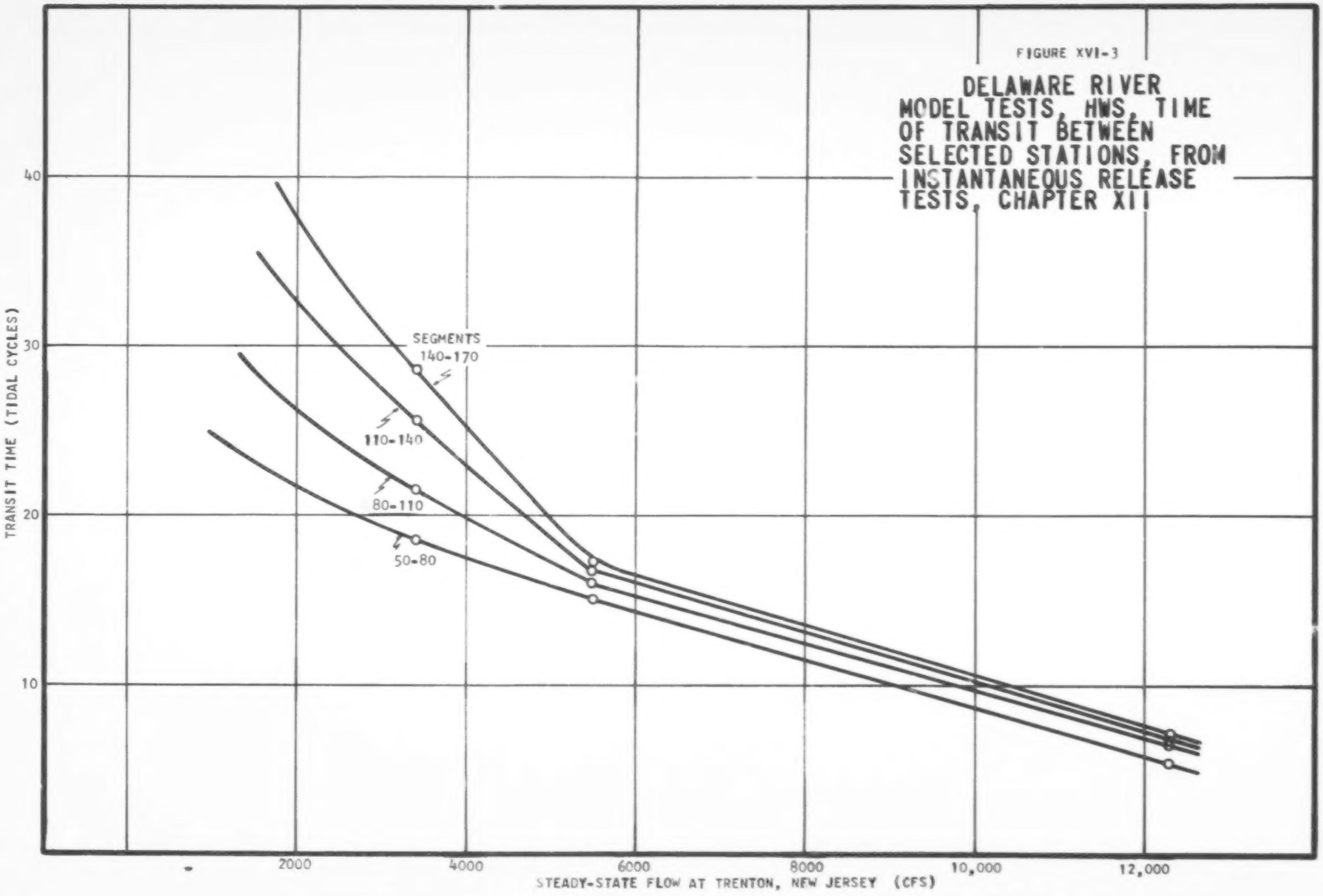


FIGURE XVI-3

DELAWARE RIVER
MODEL TESTS, HWS, TIME
OF TRANSIT BETWEEN
SELECTED STATIONS, FROM
INSTANTANEOUS RELEASE
TESTS, CHAPTER XII

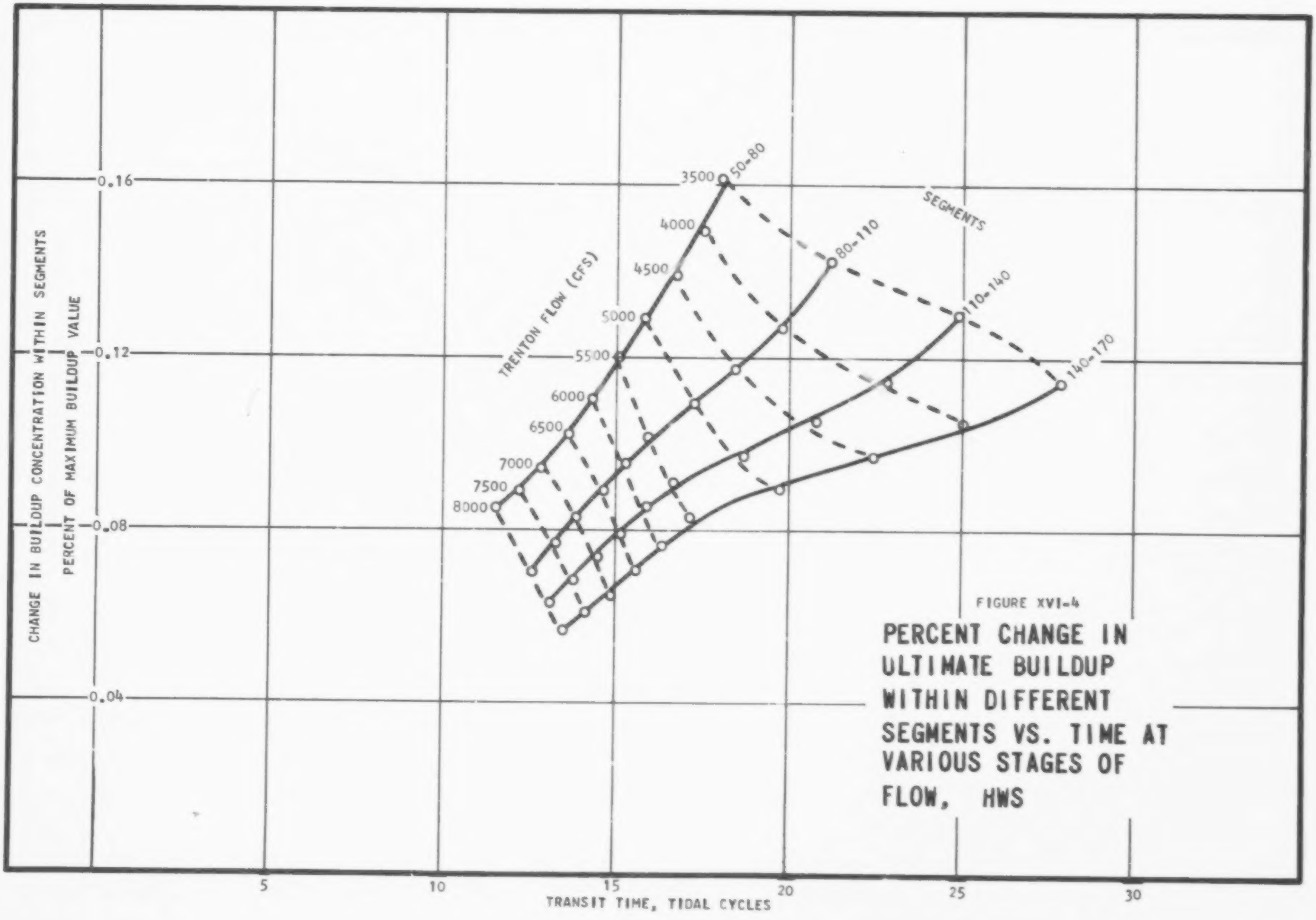


FIGURE XVI-4

PERCENT CHANGE IN ULTIMATE BUILDUP WITHIN DIFFERENT SEGMENTS VS. TIME AT VARIOUS STAGES OF FLOW, HWS

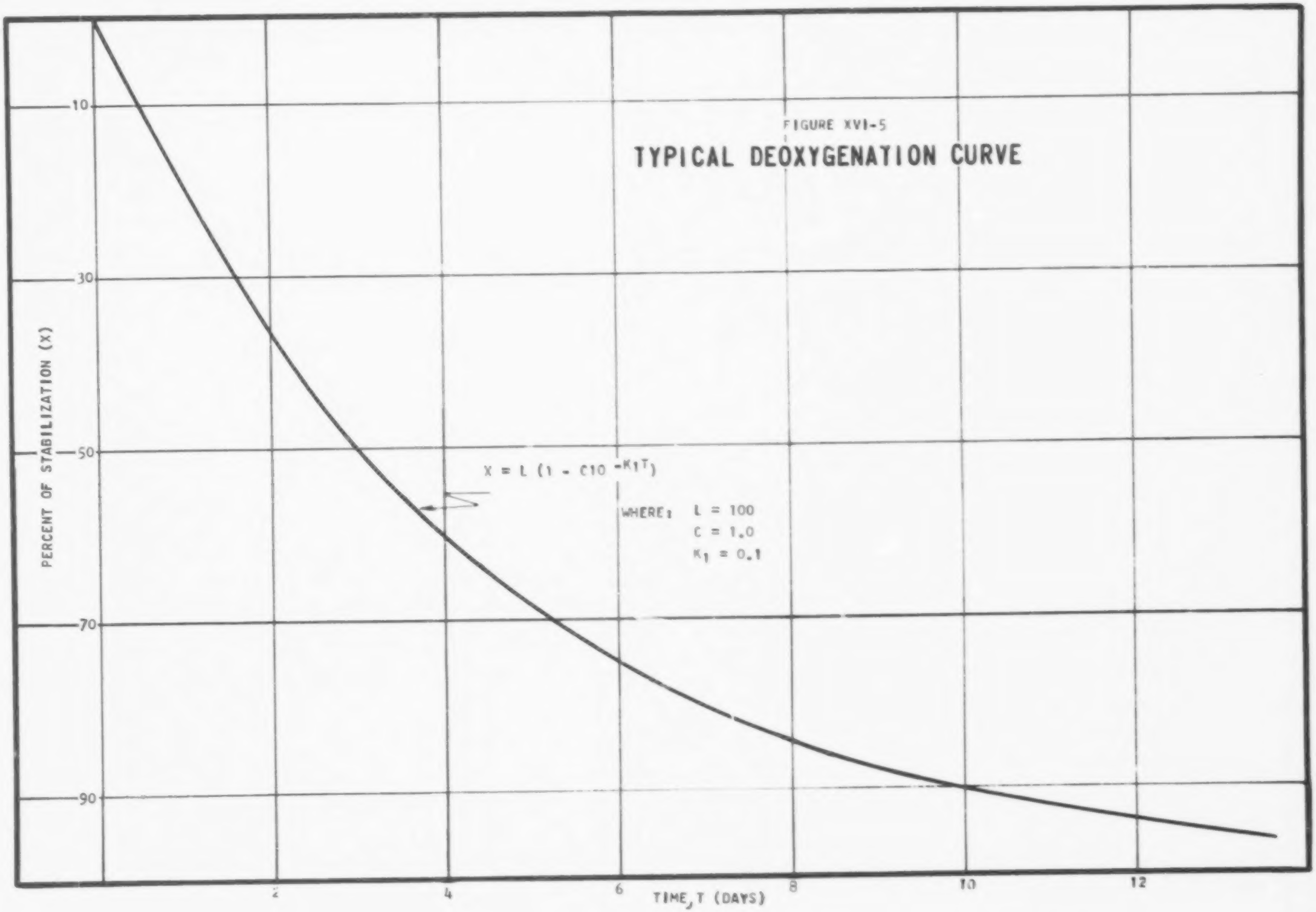


FIGURE XVI-5

TYPICAL DEOXYGENATION CURVE

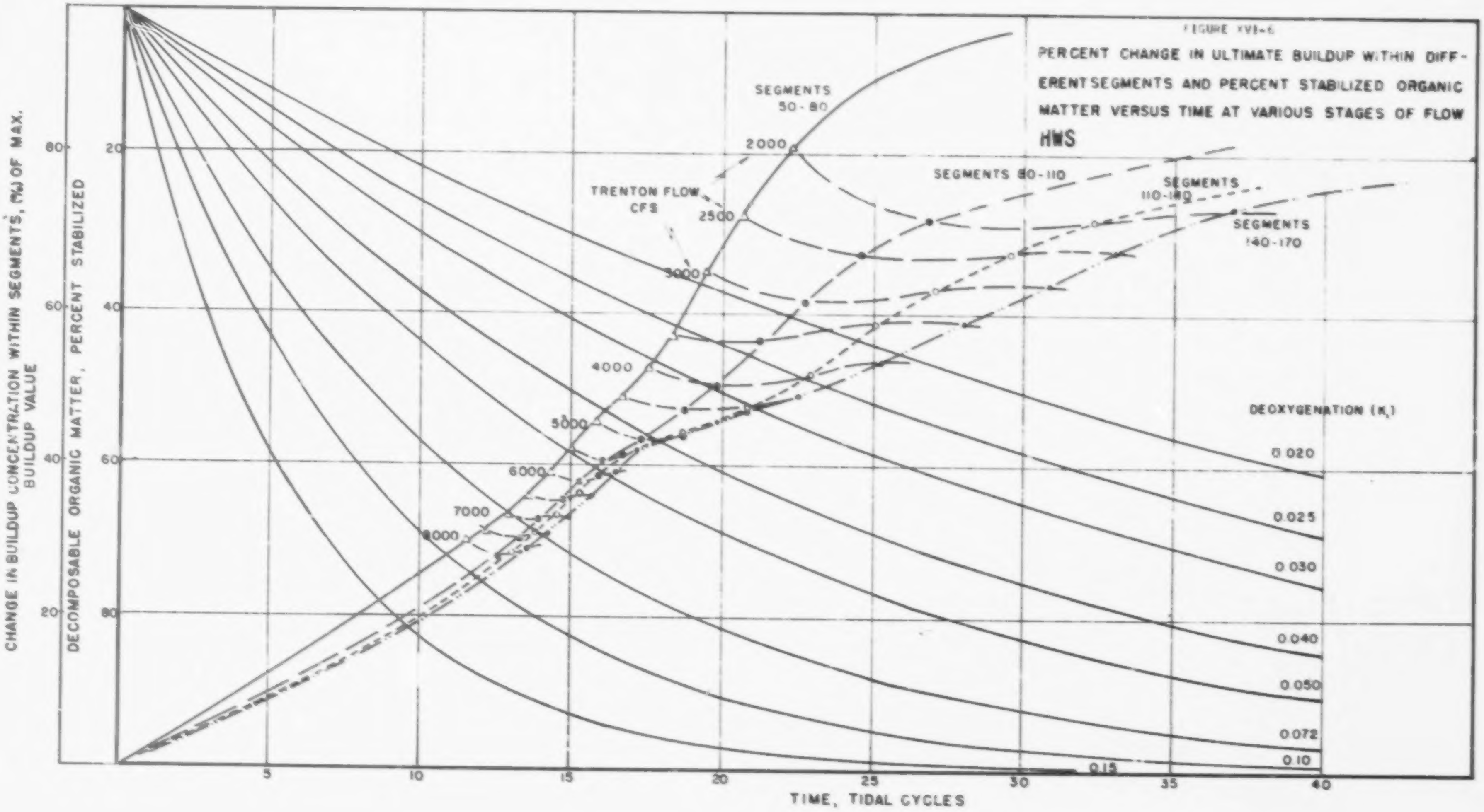


FIGURE XVI-6

PERCENT CHANGE IN ULTIMATE BUILDUP WITHIN DIFFERENT SEGMENTS AND PERCENT STABILIZED ORGANIC MATTER VERSUS TIME AT VARIOUS STAGES OF FLOW

HWS

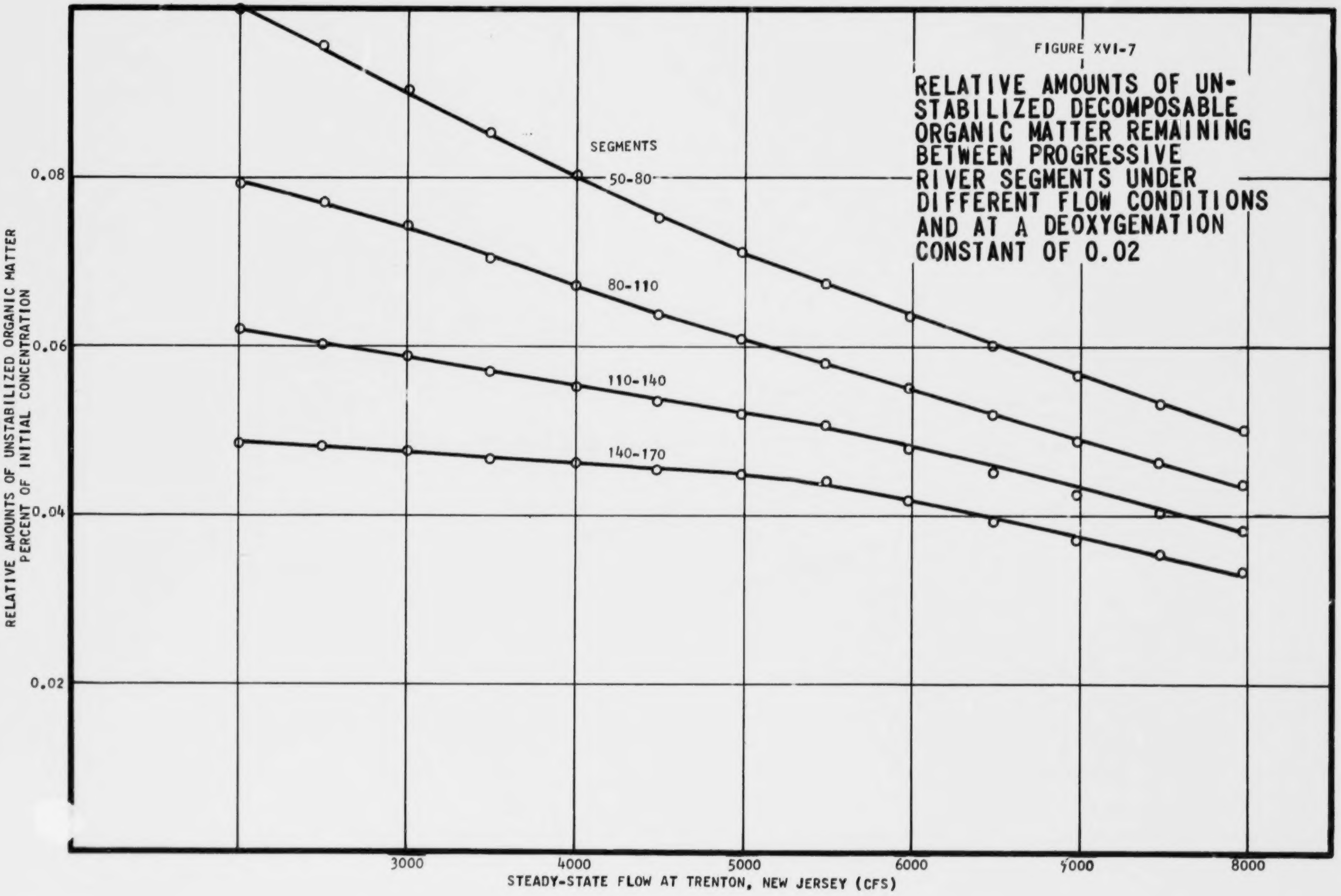


FIGURE XVI-7

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.02

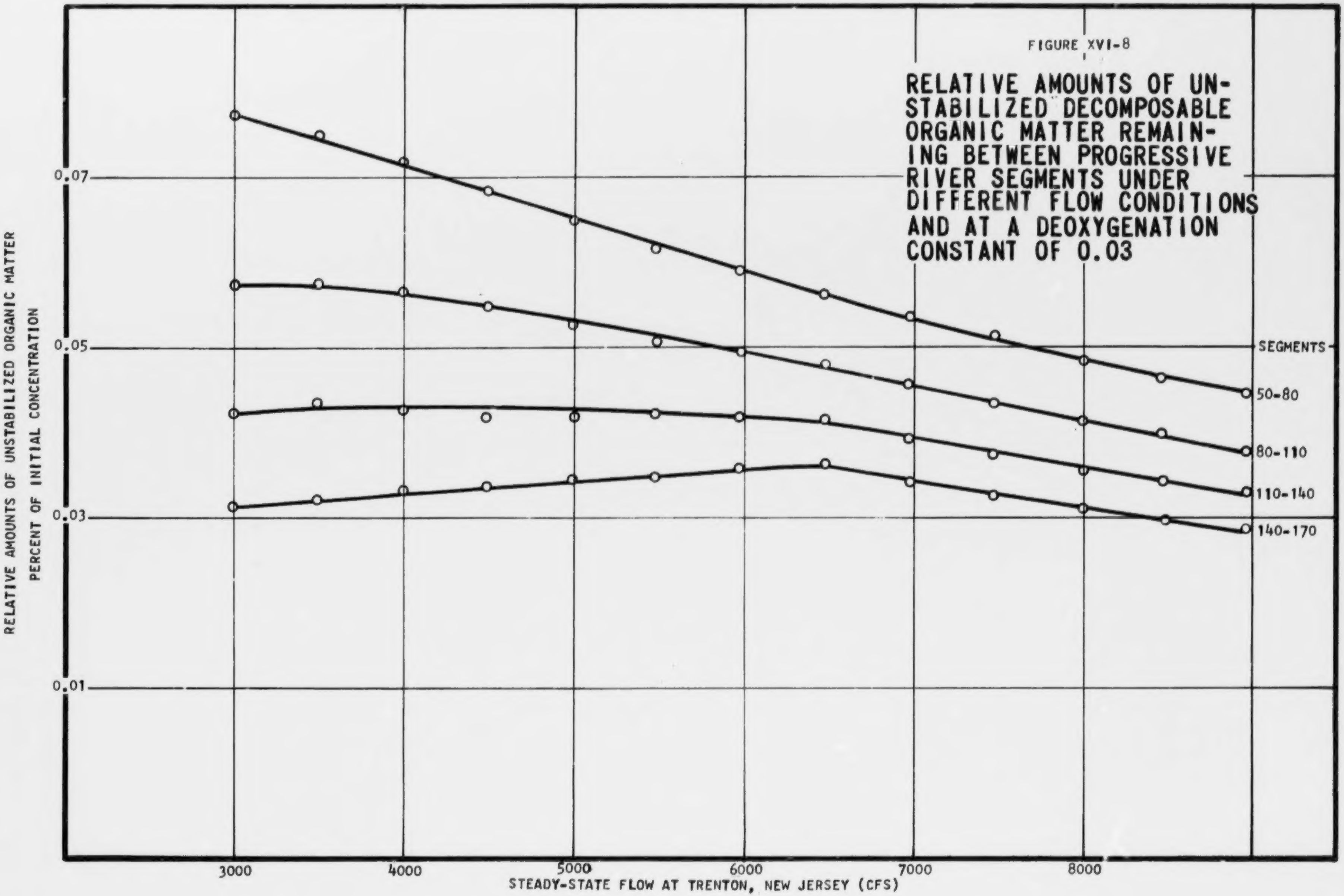


FIGURE XVI-8

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.03

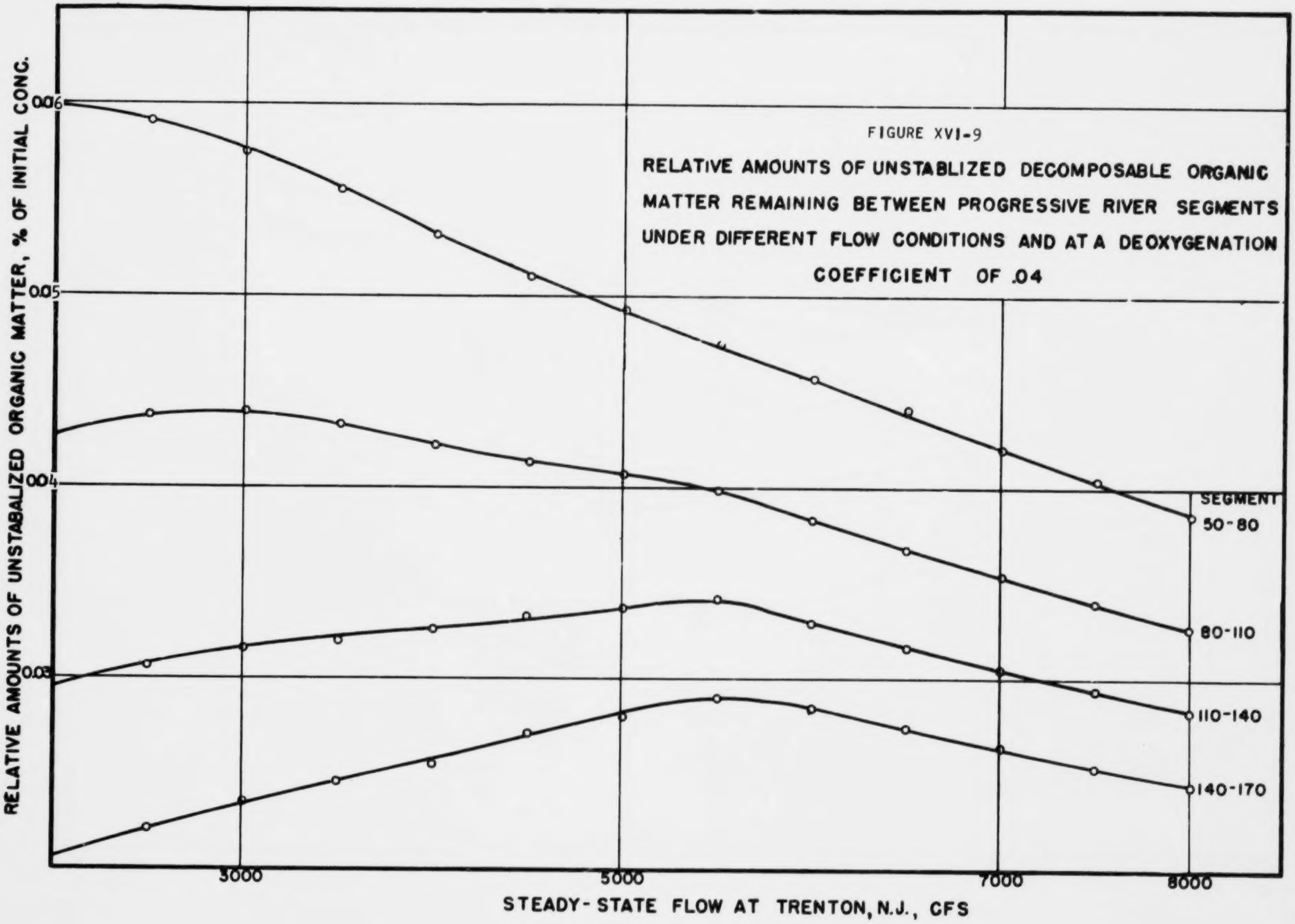


FIGURE XVI-9

RELATIVE AMOUNTS OF UNSTABLIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION COEFFICIENT OF .04

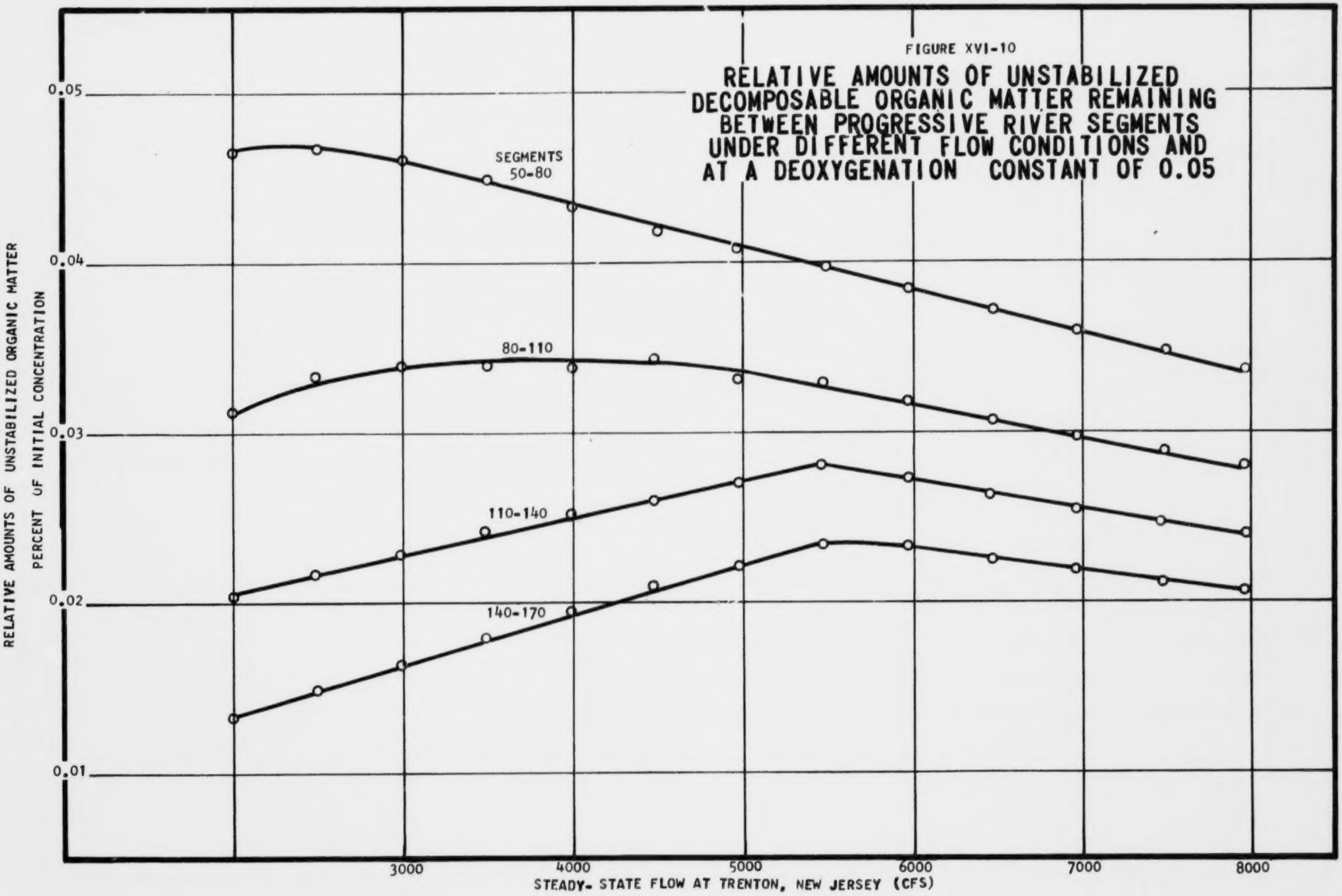


FIGURE XVI-10

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.05

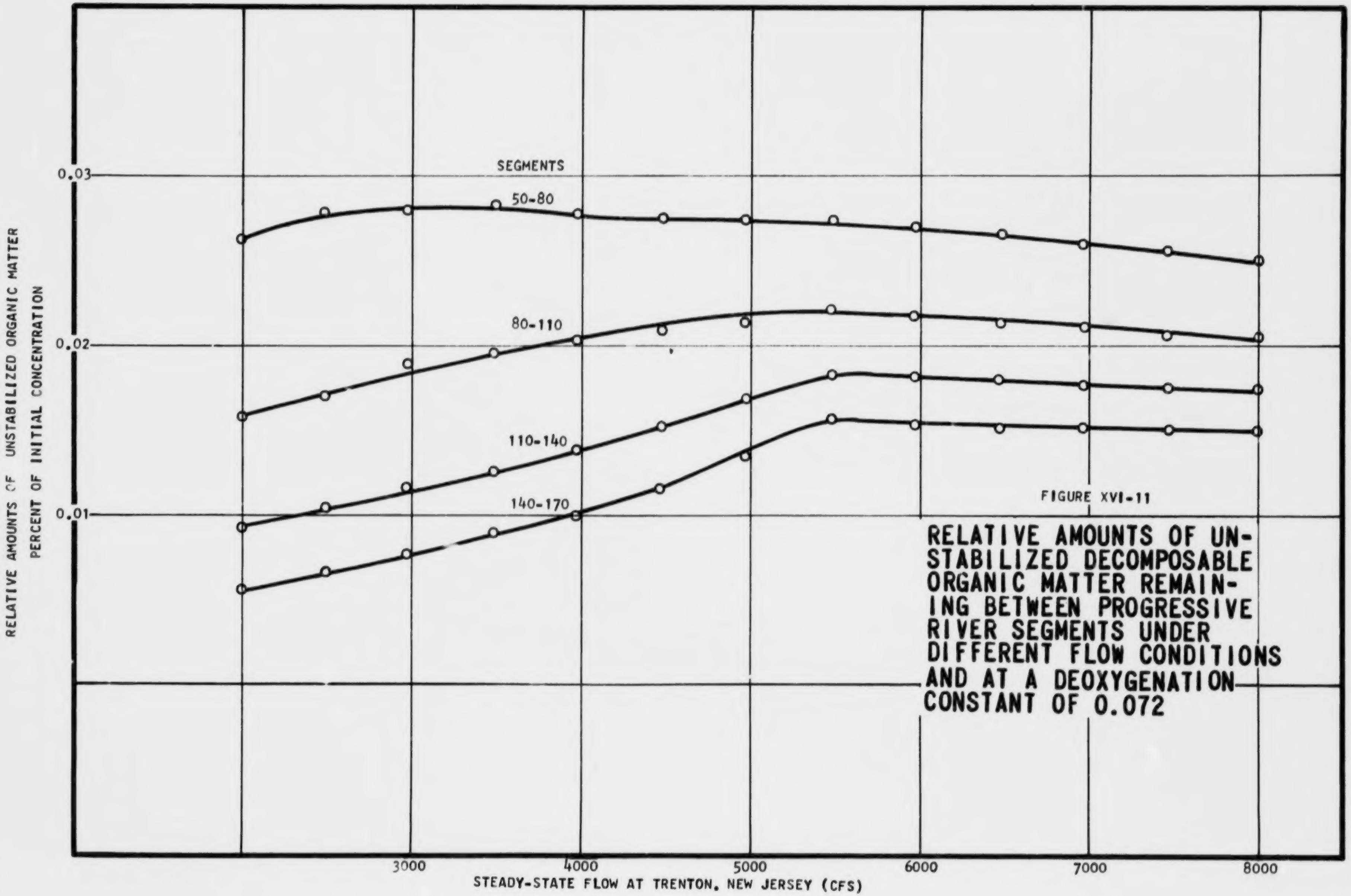


FIGURE XVI-11

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.072

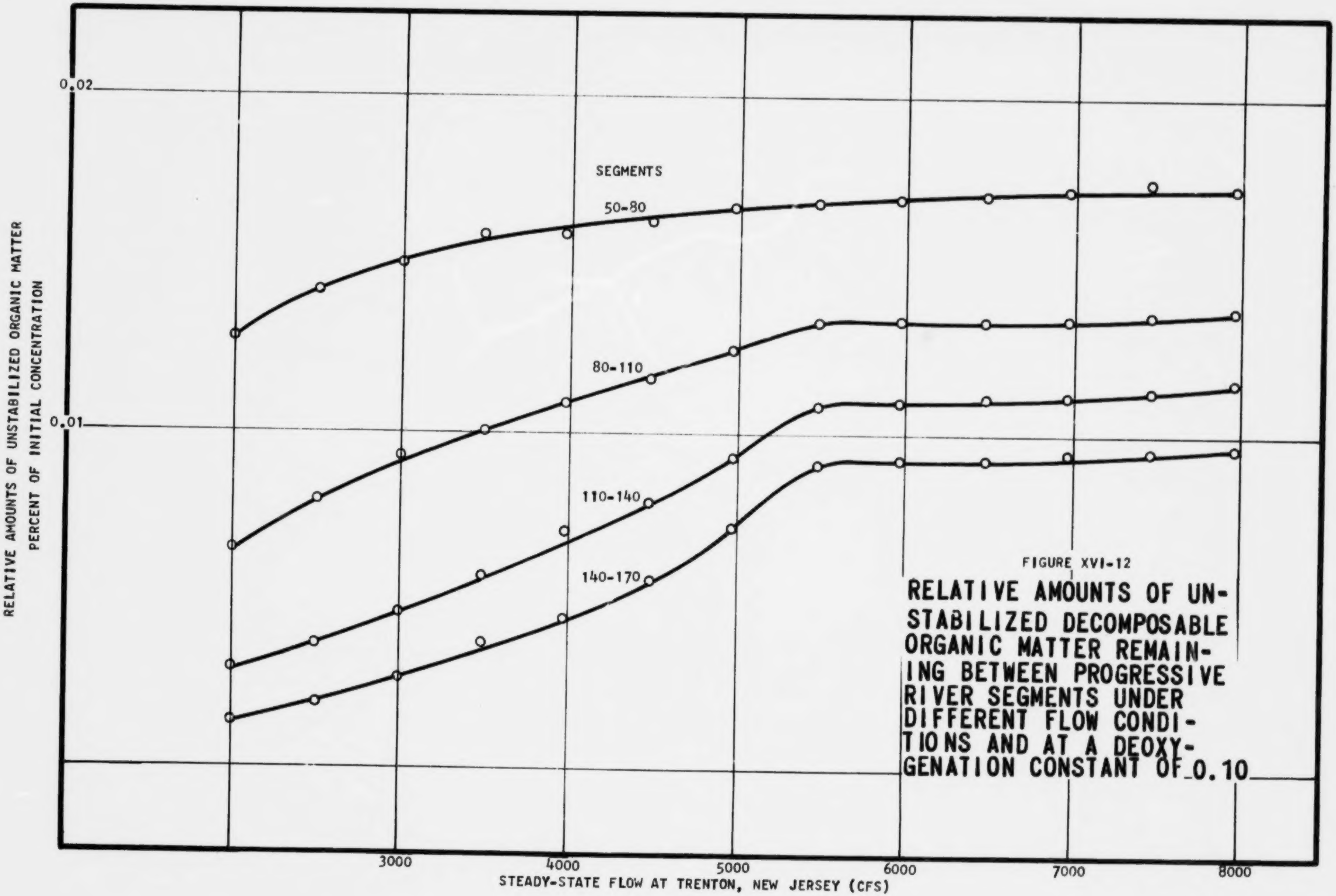


FIGURE XVI-12

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.10

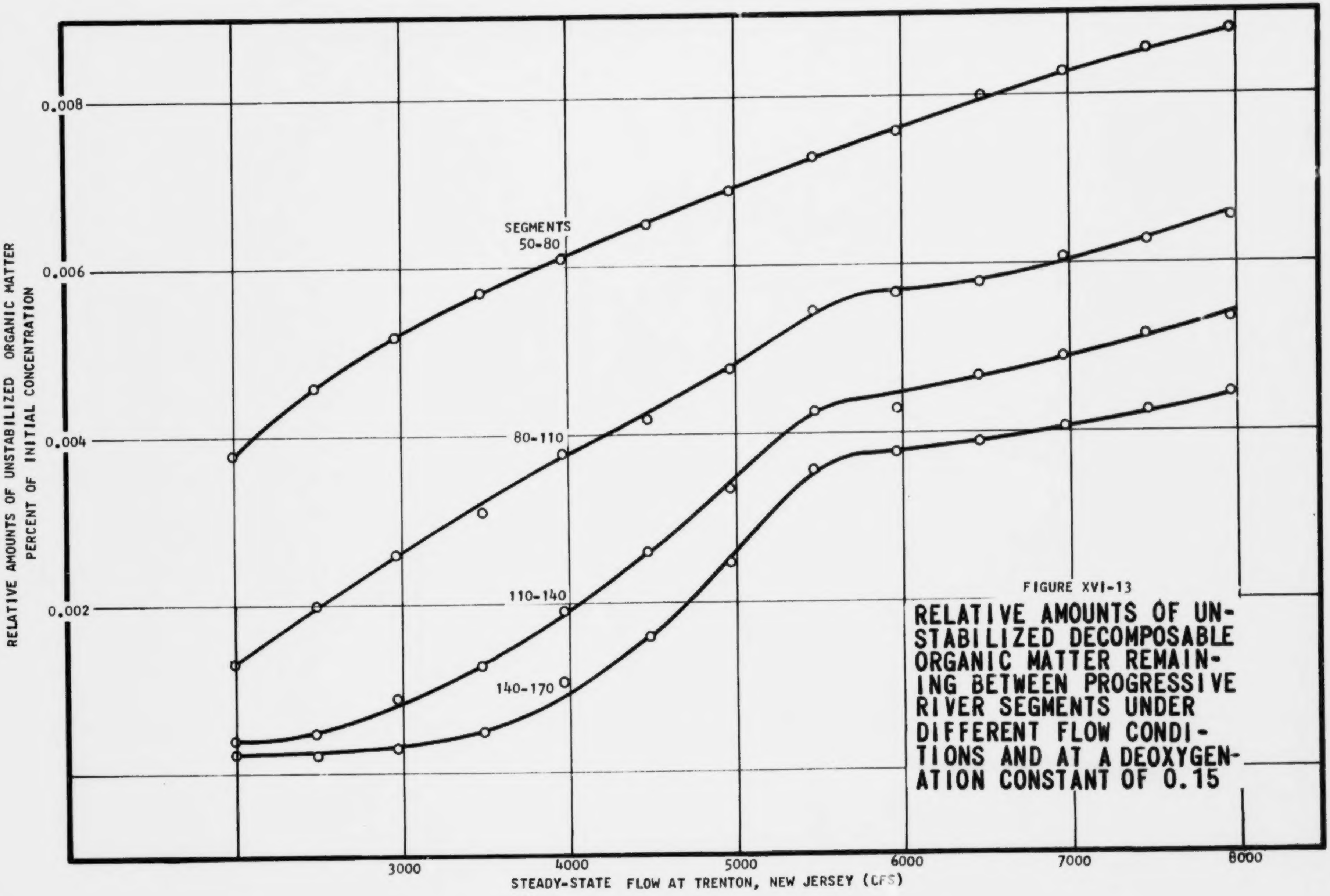


FIGURE XVI-13

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE RIVER SEGMENTS UNDER DIFFERENT FLOW CONDITIONS AND AT A DEOXYGENATION CONSTANT OF 0.15

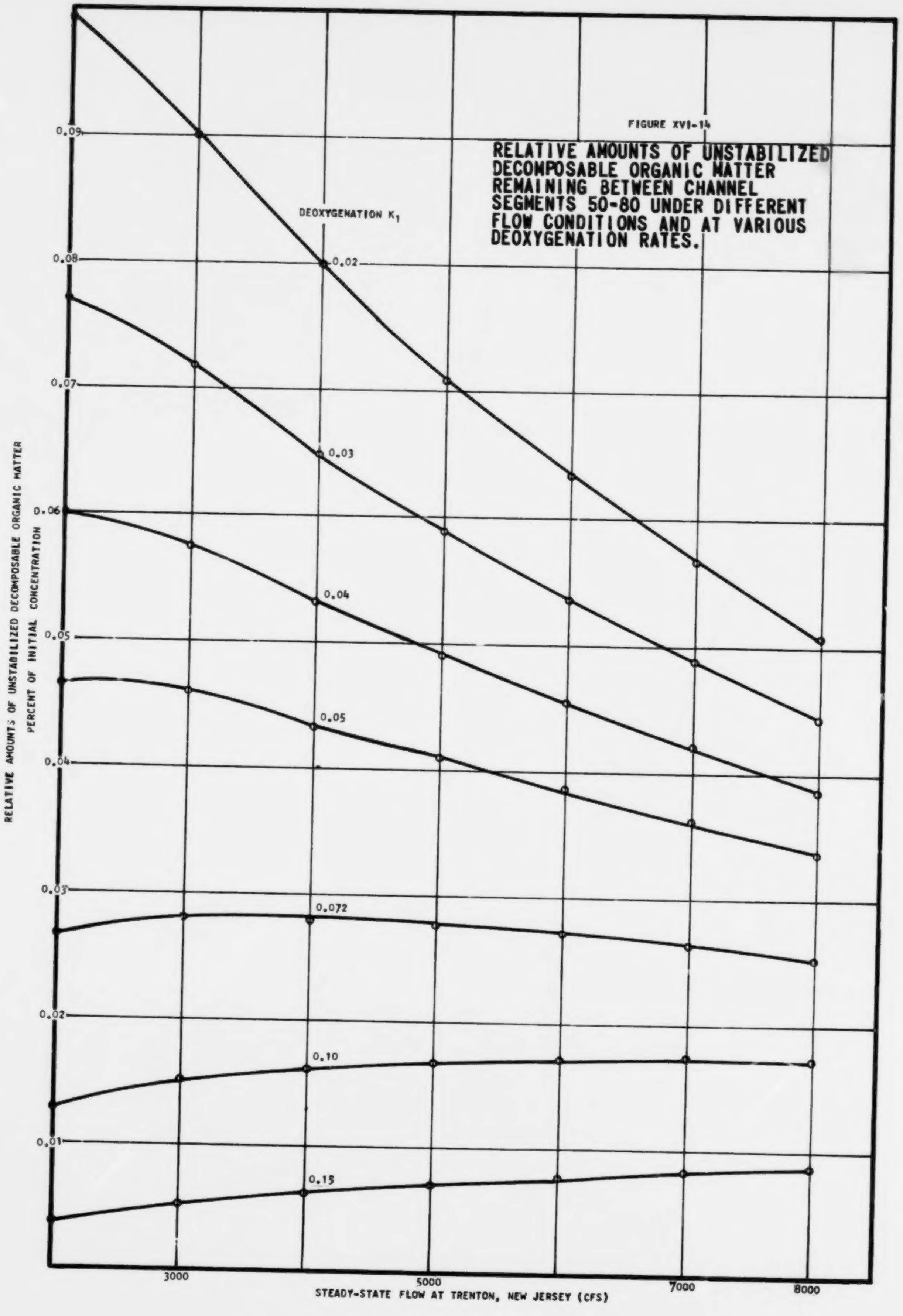


FIGURE XVI-14

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN CHANNEL SEGMENTS 50-80 UNDER DIFFERENT FLOW CONDITIONS AND AT VARIOUS DEOXYGENATION RATES.

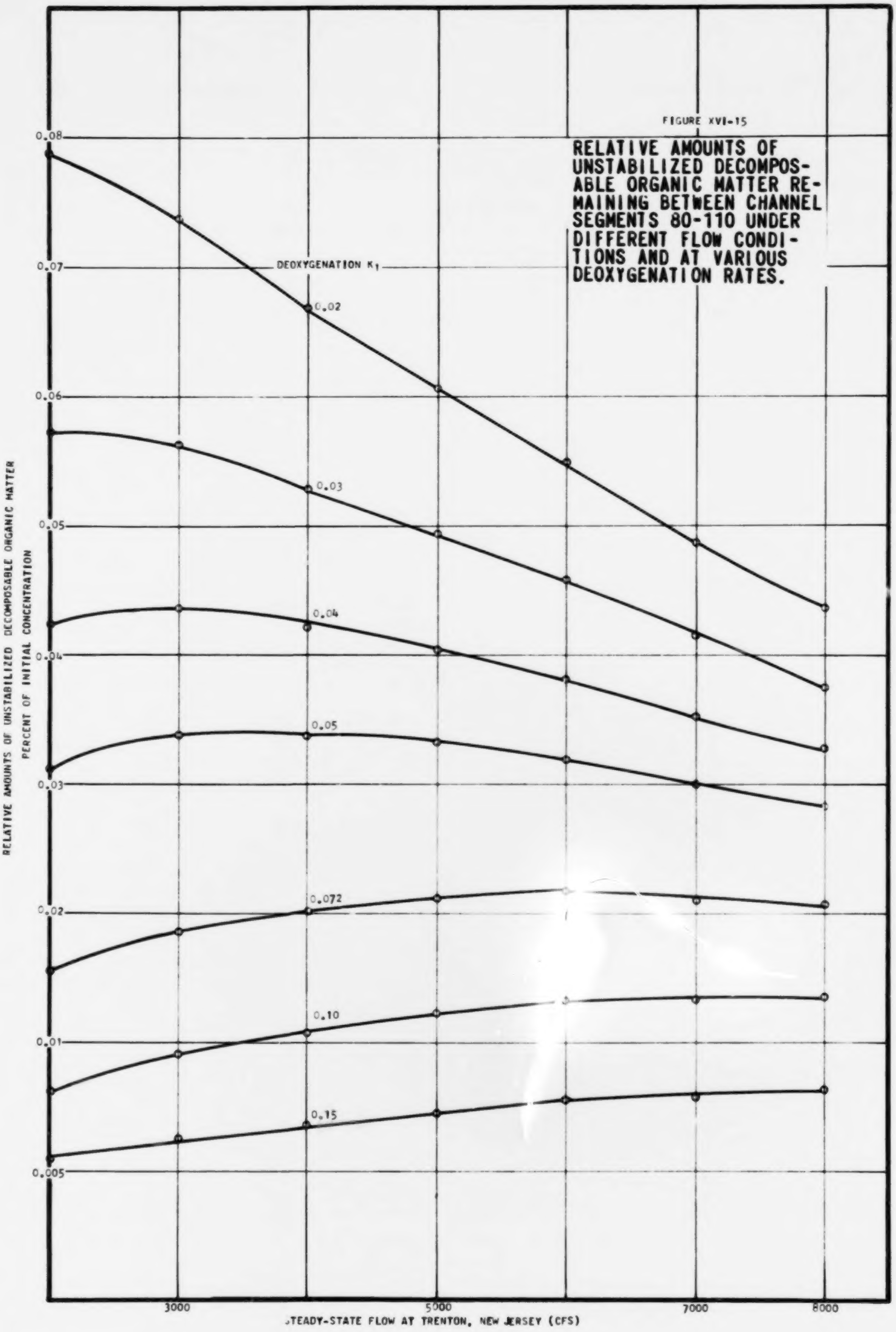


FIGURE XVI-15

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN CHANNEL SEGMENTS 80-110 UNDER DIFFERENT FLOW CONDITIONS AND AT VARIOUS DEOXYGENATION RATES.

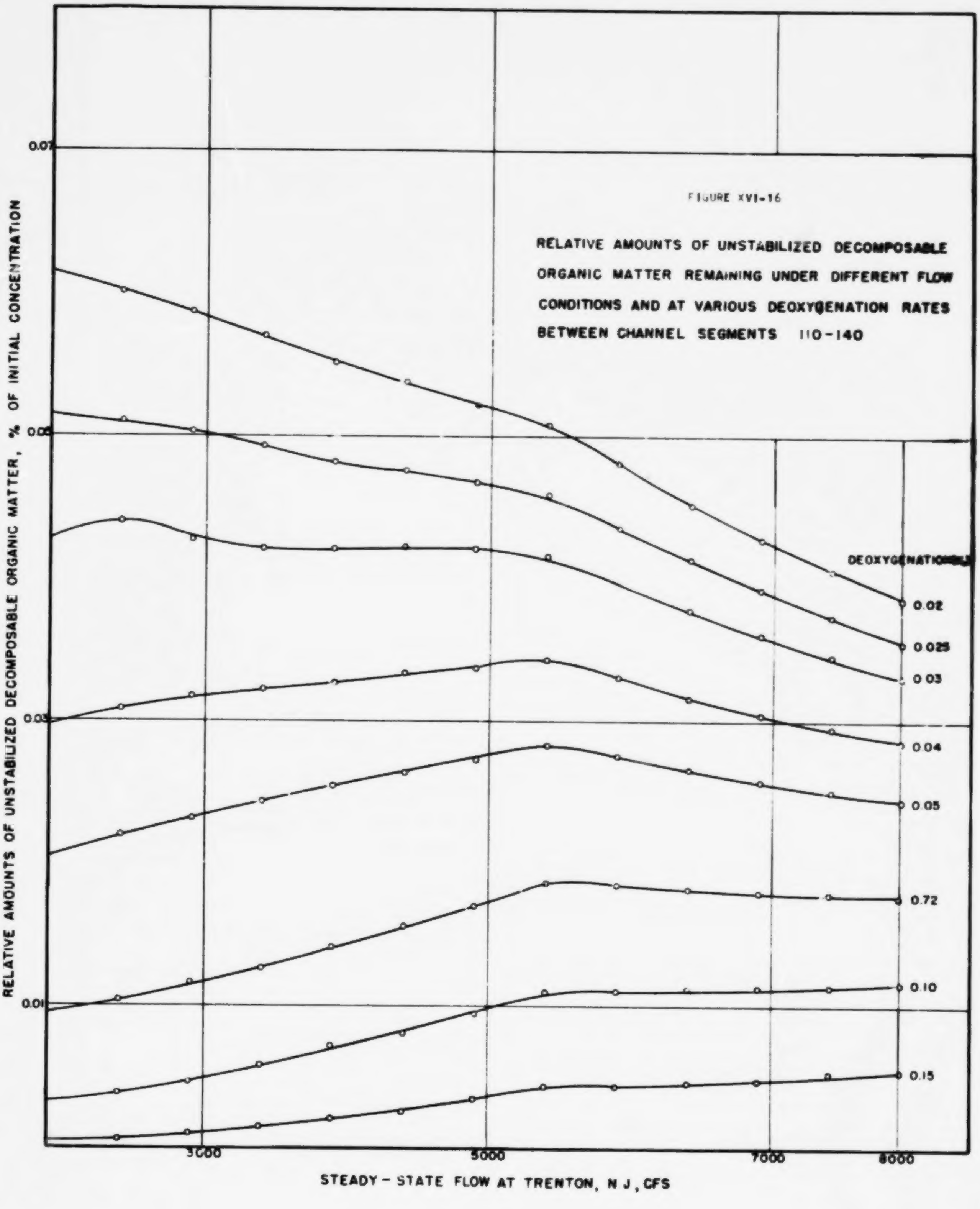
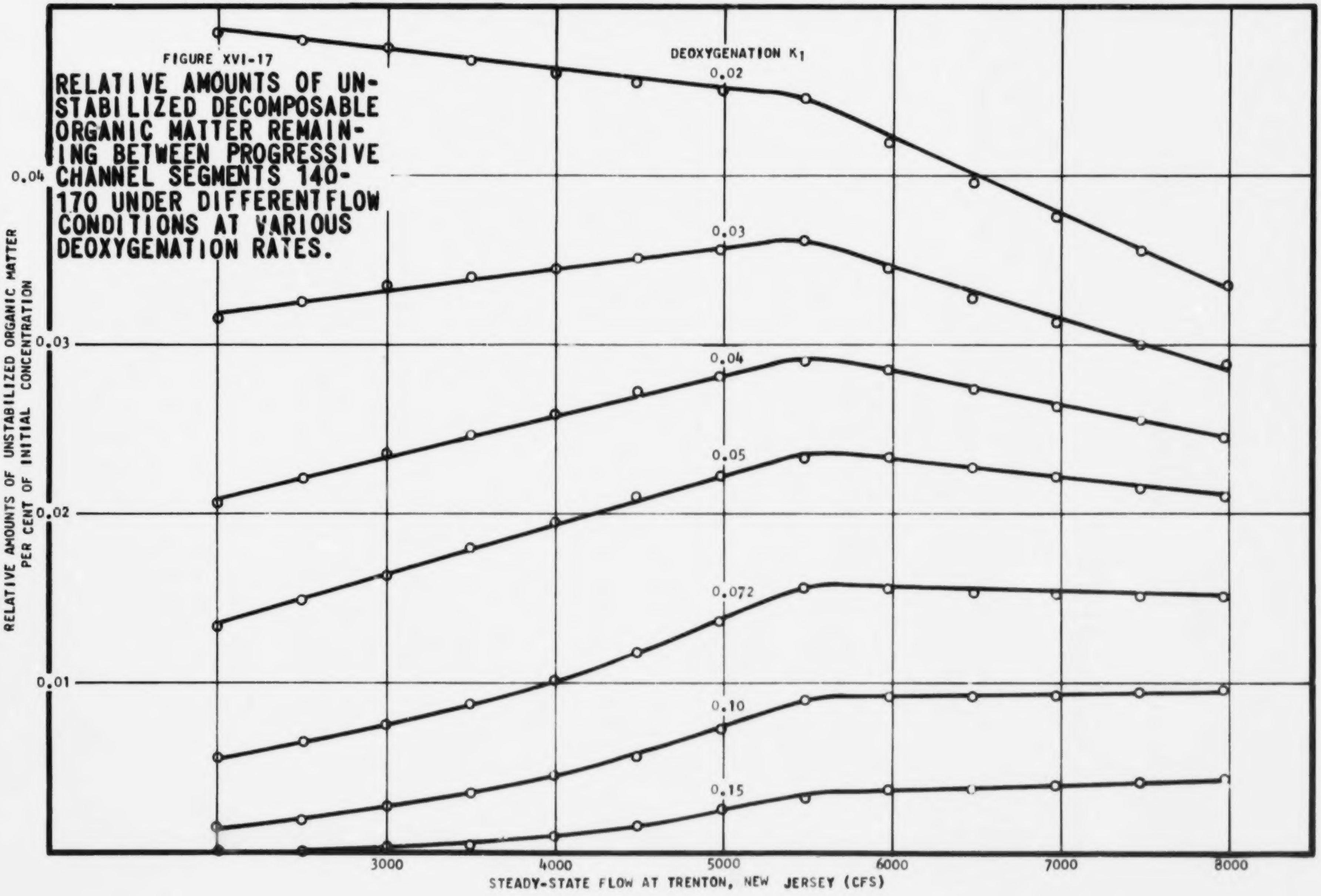


FIGURE XVI-16

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING UNDER DIFFERENT FLOW CONDITIONS AND AT VARIOUS DEOXYGENATION RATES BETWEEN CHANNEL SEGMENTS 110-140

FIGURE XVI-17

RELATIVE AMOUNTS OF UNSTABILIZED DECOMPOSABLE ORGANIC MATTER REMAINING BETWEEN PROGRESSIVE CHANNEL SEGMENTS 140-170 UNDER DIFFERENT FLOW CONDITIONS AT VARIOUS DEOXYGENATION RATES.



CHAPTER XVII

SUMMARY OF POLLUTIONAL LOADINGS INTO THE DELAWARE RIVER ESTUARY

In 1958, the U.S. Public Health Service, in cooperation with the States of New Jersey, Delaware, the Commonwealth of Pennsylvania, and Incodel (25), conducted as part of the Corps of Engineers Basin Study, a survey to determine the quantity of pollution entering the Delaware River estuary from the States of Delaware, Pennsylvania, and New Jersey. This survey covered both municipalities and industries. Where loading figures were not available, estimates were made. An inventory sheet was compiled indicating the approximate discharge location and the pounds of 5-day B.O.D. being discharged daily from each source. The total daily loading, from the inventory sheet, is 773,095 pounds of 5-day B.O.D. Table XVII-1 shows how this loading is distributed through the estuary.

TABLE XVII - 1

DISTRIBUTION OF ESTIMATED POLLUTIONAL LOADINGS IN ESTUARY AS OF 1958

Segment*	Loading 5-Day B.O.D. LBS.	River Volume Cubic Feet
-155 to -10	69,223	
-10 to 20	125,337	$4,641 \times 10^6$
20 to 50	176,932	$5,276 \times 10^6$
50 to 80	167,649	$6,476 \times 10^6$
80 to 110	85,738	$7,015 \times 10^6$
110 to 140	40,080	$7,952 \times 10^6$
140 to 170	59,268	$9,405 \times 10^6$
170 to 200	47,812	$10,490 \times 10^6$
200 +	1,056	
Total	773,095	

* Numbers indicate location x 1,000 as employed by Corps of Engineers Waterway Experiment Station at Vicksburg, Mississippi. Station 0+00 is located at Allegheny Avenue with negative values upstream and positive numbers downstream in thousands of feet.

CHAPTER XVIII

POTENTIAL DISTRIBUTION OF LOADINGS AND RESULTANT STABILIZATION

A. General

The model study results may be used to determine the manner of buildup of a conservative material discharged continuously at any point in the estuary. An attempt is made below to arrive at the 5-day Biochemical Oxygen Demand (B. O. D.) buildup concentration in the river by applying estimated pollution loadings supplied from the U. S. P. H. S. inventory (25) to model findings and prototype stabilization rates.

In the model experiments, a stable material (Methylene Blue Chloride) was used. A direct comparison, therefore, could not be made between model results and the non-conservative organic loadings. It was necessary to establish a procedure which would incorporate the stabilization characteristics of the oxygen demanding wastes. Since stabilization is a function of time, the transit time or rate of flow between any two points will, therefore, be one factor which controls the "buildup" levels of conservative and non-conservative materials discharged into the river.

It can be shown that these "buildup" levels are well approximated by a "Geometric Series" calculation. In brief, the concentration of B. O. D. in the estuary, due to a 1-day loading, is determined after stabilization has been exerted for a number of successive days. Then, depending on transit time involved, several days concentrations are added to form peak values. This addition has the form of a Geometric Series. A detailed explanation of the procedure follows.

B. Hypothetical Procedure

Due to the long transit times in the estuary, concentrations present in the river are the result of loading over an extended period of time. To determine the concentration of this material, each day's discharge is considered separately.

First, the river is divided into seven loading areas (Station -10 to Station +20, 20 to 50, 50 to 80, 80 to 110, 110 to 140, 140 to 170, and 170 to 200). That is, the many small discharges within each segment area are combined to form seven large discharges entering at the center points of the loading areas. These seven "loads" are shown in Table XVIII-1, column 3. These values come from the 1958 PHS inventory (see Chapter XVII - Table 1). The effect of each discharge, at the seven points, (Stations 5, 35, 65, 95, 125, 155, and 185) after one day is shown in the last column

TABLE XVIII - 1

CONCENTRATION OF 5-DAY B. O. D. LOADING AFTER DILUTION*

Discharge Station	Loading Area Station	Loading (lbs.) 5-Day B. O. D.	Dilution Area Station	Volume (Ft.^{3})	(C) One-Day Conc. (ppm)
5	-10 to 20	125,337	-20 to 30	$4,641 \times 10^6$	0.43
35	20 to 50	176,932	10 to 60	$5,276 \times 10^6$	0.54
65	50 to 80	167,649	40 to 90	$6,476 \times 10^6$	0.41
95	80 to 110	85,738	70 to 120	$7,015 \times 10^6$	0.20
125	110 to 140	40,080	100 to 150	$7,952 \times 10^6$	0.08
155	140 to 170	59,268	130 to 180	$9,405 \times 10^6$	0.10
185	170 to 200	47,812	160 to 210	$10,490 \times 10^6$	0.07
	TOTAL	702,816			

*Based upon estimated loadings of U. S. Public Health Service, Incodel and States (25).

of Table XVIII-1.

To find the concentration on the first day, (day of discharge), the load is divided by the volume into which it enters. From float studies in the model, it was found that the water moves approximately 10 miles from high tide to low tide, and the volume for 25,000 feet on either side of the center or discharge point was taken for this calculation accordingly. For example, to determine the first day concentration at Station 95, due to the discharge between Stations 80 and 110, the pollution loading is divided by the volume between Stations 70 and 120. Stabilization or decomposition must now be considered and can be described by the unimolecular formula:

$$x = L\,(1 - 10^{-k_1 t})$$

This formula was also employed in Chapter X to describe model data.

The percent of material which will remain after one-half day ($t=1/2$) of stabilization is equal to $10^{-1/2k_1}$, where k_1 describes the rate of stabilization. From Warburg analyses of Delaware River samples, the range of actual k_1 values has been determined. The average value of k_1 at 20° was 0.10.

Normally, pollutional discharges are assumed to be made uniformly and continuously, and to simplify a calculation without introducing an appreciable error, it is reasonable to consider all material discharged in one day as being subjected to a half-day of stabilization during the first day of discharge. With $k_1=0.1$, 89.1 percent will remain unstabilized, or 10.9 percent will be stabilized on the day of discharge. By letting t equal one and solving $10^{-k_1 t}$, the percent of material which will remain unstabilized after a full day is obtained. This will be 79.4 percent for $k_1=0.10$. So, on the second day, or the day after discharge, this percentage of the first day's discharge will remain. To better illustrate this, let;

$$C = \frac{\text{Vol. of 1-day discharge}}{\text{Vol. of segment.}}$$

r = Percent unstabilized after 1/2 day or after the day of discharge.

$= 89.1$ for $k_1=0.1$

s = percent unstabilized after 1 full day.

$= 79.4$ for $k_1=0.1$

x_t = Concentration at time t

then:

For the discharge at Station 5, $x_1 = rC$

$C = 0.43$ ppm (From Table XVIII-1), and

$$x_1 = 0.891 \times 0.43$$

$$= 0.38 \text{ ppm}$$

After two days this will be reduced to;

$$srC$$

At Station 5;

$$srC = 0.794 \times 0.891 \times 0.43$$

$$= 0.794 \times 0.38$$

$$= 0.30 \text{ ppm}$$

The concentration after two days will equal what is left of the first days discharge (srC), plus the concentration due to a new discharge (rC), or:

$$x_2 = srC + rC$$

At Station 5, this becomes;

$$x_2 = 0.30 + 0.38$$

$$= 0.68 \text{ ppm}$$

and similarly:

$$x_3 = ssrC + srC + rC$$

$$= s^2rC + srC + rC$$

$$x_4 = s^3rC + s^2rC + srC + rC$$

It will be noticed that in the above expression, the ratio of each term to the preceding term is a constant. This is a Geometric Series. The sum of this series can be written:

$$x_t = rC\left[\frac{1-s^t}{1-s}\right]$$

If it takes ten days for the first days discharge to move downstream to a point where it no longer influences Station 5, then the maximum concentration which will occur at Station 5, due to this discharge at Station 5, is found by letting t = 10 in the above formula.

In applying this formula to a point downstream of the discharge, where there is a time lag before the pollution arrives, the pollution which is discharged during the lag period must be subtracted from the peak value. Mathematically:

$$x = x_{t_2} - x_{t_1}$$

or $$x = \frac{rC}{1-s}\left(s^{t_1} - s^{t_2}\right) \qquad \text{Equation (1)}$$

Where t_1 is the time lag before the first discharge reaches the point in question; and t_2 is the time required for the first discharge to pass the point. The required transit times were obtained from Chapter XII.

In the above procedure, no allowance has been made for the normal change in concentration which occurs even in stable pollutants. This change is due to the configuration of the river downstream of the discharge point. This change in concentration is in addition to that due to stabilization. Plots of log peak concentration versus location, using model study data, form straight lines (See Figure X-8). For the various flows studied, these lines are parallel. This indicates a constant relationship between concentrations.

This constant has been determined and is used as follows:

$$\frac{\log C_1 - \log C_2}{d_1 - d_2} = \text{Constant} = \text{"a"}$$

Where C_1 = ultimate concentration at Station d_1, and C_2 = ultimate concentration at Station d_2. Both concentrations are due to a discharge upstream from Station d_1.

$$\log C_1 - \log C_2 - a\,(d_1 - d_2)$$

$$\frac{C_2}{C_1} = e^{a(d_2 - d_1)}$$

From model study data, (Chapter X, Fig. 8) "a" equals -3.97×10^{-3}, letting C_1 equal the ultimate concentration at the discharge Station (d_1), then the concentration (C_2) at any downstream point (d_2) would equal:

$$C_2 = e^{a(d_2 - d_1)} \times C_1.$$

This is without stabilization.

To combine this with stabilization, the value $e^{a(d_2-d_1)}$ is multiplied by the concentration at d_1 which was determined by the geometric build-up procedure where d_1 is the point of discharge. The following Table indicates the factors used for adjusting this change in concentration.

This complete procedure has been applied using pollution loadings, reported in the U.S.P.H.S. inventory. The results are shown in Table XVIII-3. However, the peak values obtained are not within the range of the B.O.D. values known to exist within the estuary.

TABLE XVIII - 2

FACTORS AND ADJUSTING CONCENTRATION FOR RIVER CONFIGURATION

Distance from Discharge Point at 1,000 feet ($d_2 - d_1$)	Factor $e^{a(d_2 - d_1)}$
30	0.8876
60	0.7878
90	0.6992
120	0.6204
150	0.5505

In an attempt to further evaluate these results, it is known that complete stabilization is achieved during the longer transit time and it can be assumed that the total oxygen demand exerted on the river in any one day is equivalent to the ultimate oxygen demand (U.O.D.) of a one-day discharge. This must also be equivalent to the oxygen supplied to the river on that day. This balance between U.O.D. and the daily oxygen supply must exist in order to maintain the equilibrium which occurs in the river.

The oxygen supplied to the system each day, through reaeration, is a function of the oxygen deficit. This is the minimum amount supplied since additional oxygen is made available through photosynthesis and tributary dilution. The oxygen deficit of the estuary has been shown for 9/15/58 in Table XIV-2.

Imhoff and Fair (13) have classified various bodies of water. For each classification they have indicated the daily reaeration as a percentage of the constant oxygen deficiency. Their average figures appear in Chapter XIV.

Phelps (19) gives a formula by which the daily oxygen supplied through reaeration might be calculated. Results of applying his formula appear in Table XIV-1.

Applying these figures to the oxygen deficit for 9/15/58, it was calculated that between 2.6 and 3.6 million pounds of oxygen are added to the river each day. Using an U.O.D. to 5-day B.O.D. ratio of 2.6, (the average value from prototype studies), the U.O.D. of the U.S.P.H.S. inventory loading is 2 million pounds, which is considerably less than the minimum oxygen supplied

TABLE XVIII - 3

BUILDUP* OF 5-DAY B.O.D. (PPM) BY GEOMETRIC SERIES AT 5,000 CFS STEADY-STATE FLOW AND DEOXYGENATION OF 0.1

Discharge Point	Effect of Discharge at Station No.						
	5	35	65	95	125	155	185
5	1.44	0.44	0.11	0.01			
35	1.08	1.91	0.48	0.07	0.01		
65		1.10	1.59	0.23	0.03		
95			0.57	0.81	0.11	0.02	
125				0.24	0.33	0.04	0.01
155					0.31	0.41	0.04
185						0.22	0.29
Total	2.52	3.45	2.75	1.36	0.79	0.69	0.34

*HWS and Loadings from original estimated inventory

SAMPLE CALCULATION:

For discharge @ sta. 5
effect @ sta. 65

From Fig. similar to XII-12 for 5,000 cfs flow:

t_1 from sta. 5 to 65 = 10.1 days

t_2 from sta. -95 to 65 = 16.6 days

$$\text{From Eqn. (1)} = \frac{0.891\,(0.43)}{0.206}\quad(0.794^{10.1} - 0.794^{16.6}) = 0.14$$

Adjusting from Table XVIII-2 for 60,000 foot distance from discharge point.
Effect @ Sta. 65 = 0.14 (.7878) = 0.11 ppm.

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by reaeration alone. However, it should be pointed out here that oxygen demanding material such as storm overflow. benthal demand and plant material have yet to be considered.

To further evaluate the proposed procedure, the loadings have been increased arbitrarily to include all sources so that there is a balance between the daily oxygen supply (reaeration) and the U.O.D. The revised loadings are shown in Table XVIII-4. Using the modified loadings, the entire procedure to determine ultimate concentrations was made for a stabilization rate "k_1" of 0.10 at flows of 3,000; 5,000; and 7,000 cfs. At a flow of 5,000 cfs, calculations were also made for "k_1" values of 0.075 and 0.125. The results are listed in Tables XVIII-5, 6, 7, 8, and 9, of the Appendix. These results are within the range of 5-day B.O.D. values existing in the river.

The effect of flow on concentration is seen by comparing Tables XVIII-5, 6, and 7 of the Appendix. In the upstream areas, concentrations decrease with higher flows. The opposite is often true in downstream areas. That is, higher B.O.D. concentrations occur at higher flows, (See Figure XVIII-1).

A comparison of Tables XVIII-6, 7, 8, and 9 of the Appendix indirectly reveals the effect of temperature at constant flow. The lower the temperature the slower stabilization will take place, and

TABLE XVIII - 4

COMPARISON OF ESTIMATED AND MODIFIED ESTIMATED 5-DAY B.O.D. LOADINGS

Station Segment	Estimated Inventory*, Lbs.	Modified Estimate, Lbs.
-10 to 20	125,337	175,000
20 to 50	176,932	225,000
50 to 80	167,649	467,000
80 to 110	85,738	185,000
110 to 140	40,080	165,000
140 to 170	59,268	135,000
170 to 200	47,812	48,000
	702,816	1,400,000

*Does not include other potential oxygen demanding material such as storm overflow benthal demand and material (natural organic occurring).

the higher will be the ultimate buildup concentration. If the 20°C "k_1" value is 0.10, then a "k_1" of 0.075 will correspond to a temperature of 13.8°C. A temperature of 24.9°C will produce the "k_1" 0.125. Figure XVIII-2 compares buildup at these various "k_1" values.

The above presentation provides a procedure whereby model study data, prototype findings, and waste loading inventory may be combined to establish resultant B.O.D. concentrations at various levels of steady-state flow and temperature during continuous discharge of non-conservative material into the Delaware River estuary. Further study is indicated, not only to expand and/or make more finite evaluations, but to improve the loading inventory by making detailed Warburg analysis of the major waste sources tributary to the Delaware River. It is conceivable that as the inventory is projected, the loadings will be found to exceed the oxygen supplied through reaeration, and further detailed study will become necessary with regard to oxygen supplied through photosynthesis and tributary dilution.

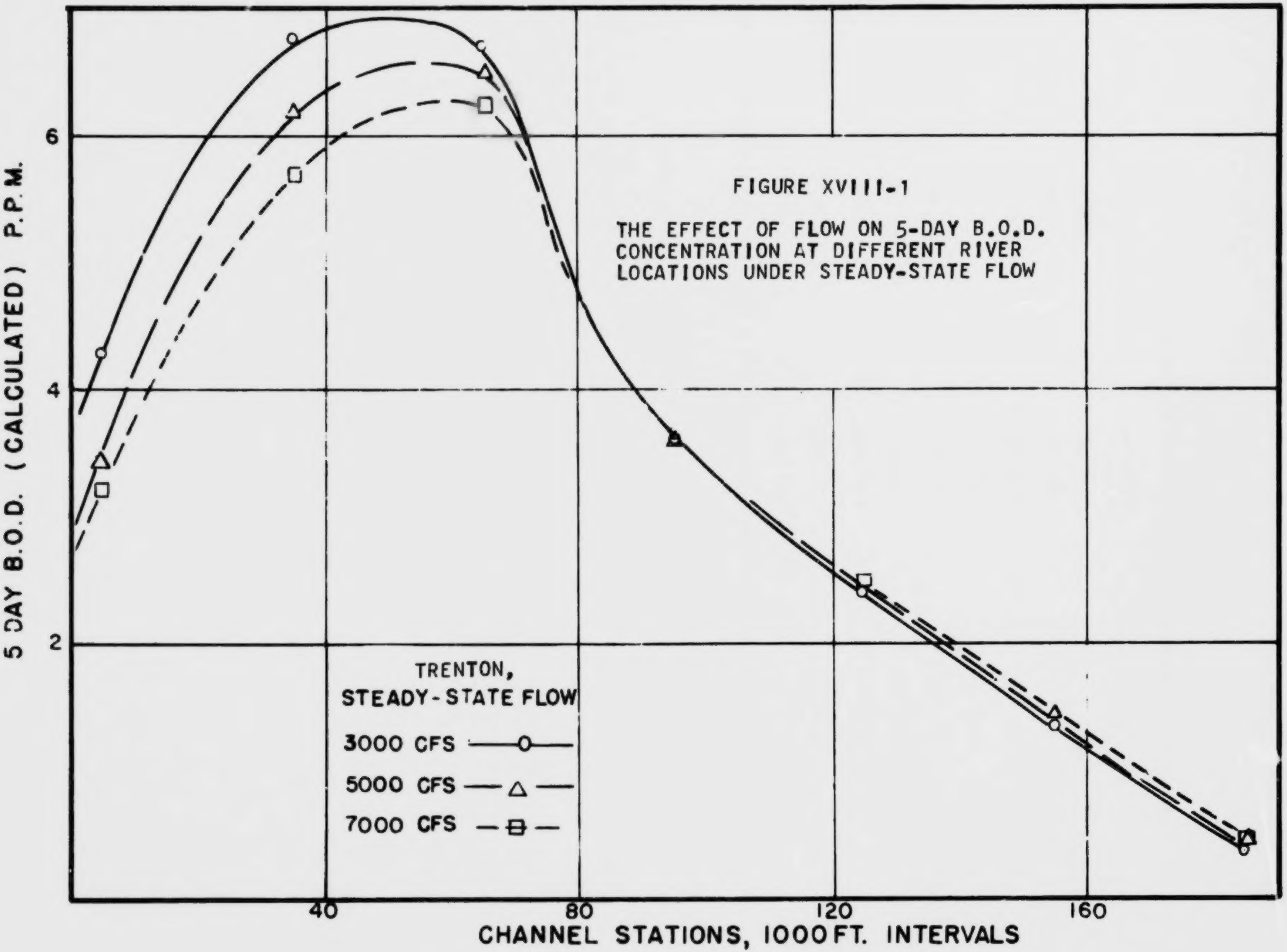

FIGURE XVIII-1

THE EFFECT OF FLOW ON 5-DAY B.O.D. CONCENTRATION AT DIFFERENT RIVER LOCATIONS UNDER STEADY-STATE FLOW

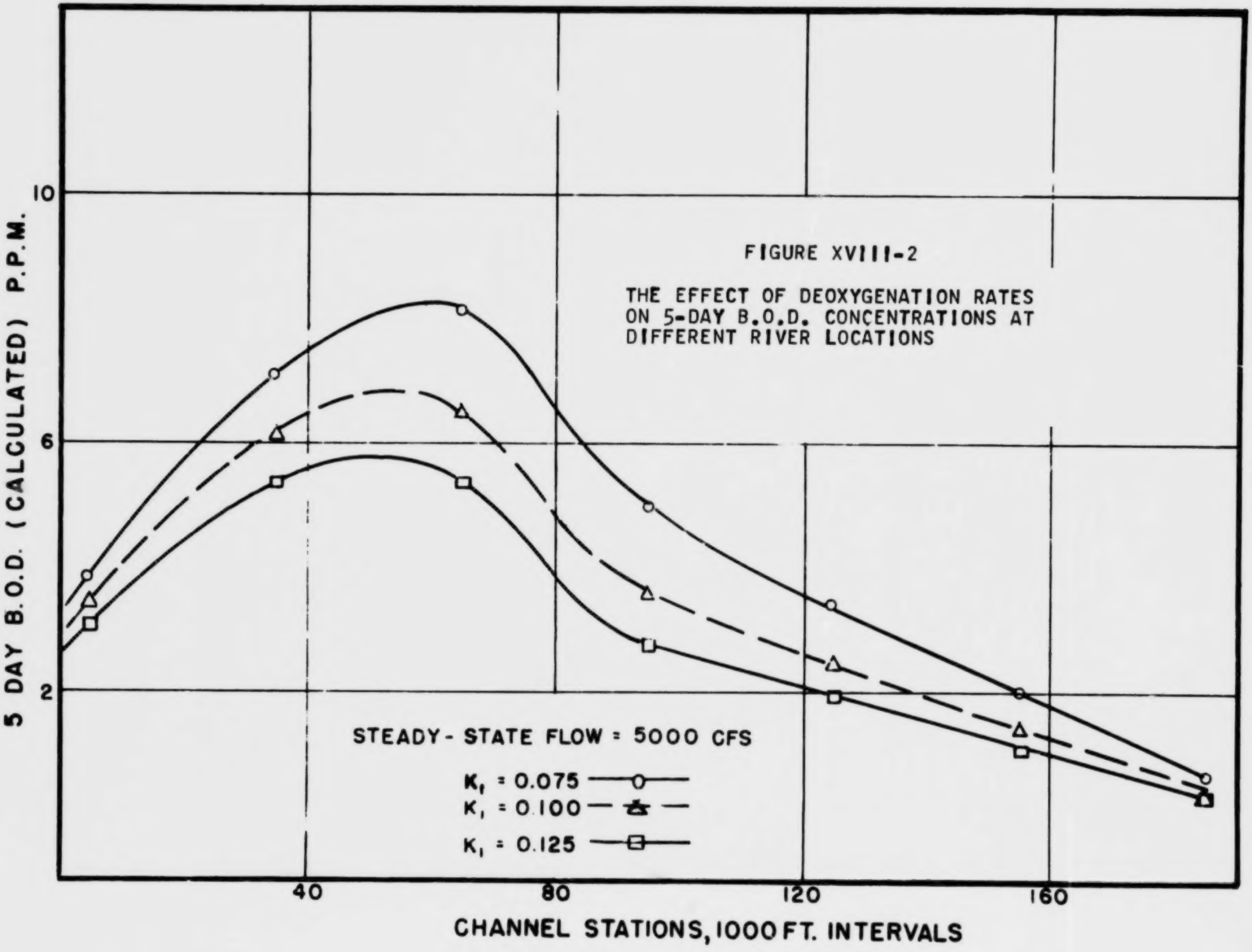

FIGURE XVIII-2

THE EFFECT OF DEOXYGENATION RATES ON 5-DAY B.O.D. CONCENTRATIONS AT DIFFERENT RIVER LOCATIONS

GENERAL DISCUSSION

Many interesting and noteworthy findings have been brought to light during the compilation and evaluation of the model study data. In addition, the application of the model study results with presently accepted theory in regard to waste stabilization, coupled with the findings developed from prototype studies during the past several years, present several possibilities toward establishing the mechanism of stream purification capacity within tidal estuaries. Many significant points were emphasized throughout the text, however, several of the more pertinent observations warrant further discussion.

Part I - Delaware River Estuary Model Study

For many years model study work on the Delaware River was based upon instantaneous releases of a conservative material and observing its movements through a number of tidal cycles. The primary reservations by those studying pollution problems with regard to employing a model were directed towards not only the use of a conservative material which was not representative of organic decomposable material, but also the fact that discharges were not made in a continuous manner during the model studies. However, in recent years, the latter reservation was overcome when the duPont Company, and shortly after, the New Jersey Zinc Company, performed continuous type experiments on the model of the Delaware River at Vicksburg, Mississippi. Some hesitation is still evident with regard to employing model study information to develop waste stabilization characteristics in the tidal estuary simply because the former problem was not overcome.

It appeared logical that the model study results could be utilized if a full realization of the limitations were considered. Consequently, the model study experiments were designed to develop only the dispersion characteristics under continuous discharge conditions and transit time. These findings would then be coupled with the present knowledge of waste stabilization. Further, since flow was considered a major factor, the effect of this variable upon concentration buildup was considered a vital part of the investigation.

Prior to this series of testing, comparatively little attention was given to the dye loss aspects. Most of the earlier experiments were based upon an instantaneous release method and resolving for dye loss was not considered justified (as our findings also confirm). In a batch-type study, the dye of equal age and the maxima of the various peaks formed, plus their movements, are not altered by a loss of dye.

With continuous dye release experiments, the loss of conservative material can have a significant effect upon the final results. This is particularly true since the actual ultimate buildup concentrations with regard to pollution are an important issue. Unfortunately, the importance of making a correction for dye loss was not fully realized during the experimentation period, and considerable time and effort was expended after completion of the studies towards resolving this problem. Certain experiments could have been performed, such as measurement of the amount of dye adsorbed per square foot of wetted perimeter, during the study period and considerable waste motion could have been avoided. However, due to the lack of foresight with regard to dye loss, it was necessary to develop the effect of time, concentration, age, wetted perimeter, and bay loss under various conditions. This latter approach proved to be extremely time consuming; however, the results justified the efforts. The Waterways Experiment Station was most helpful in providing wetted perimeter area and information on time and concentration even after the experiments had been completed and the importance of dye loss correction became fully known. Obviously, in any future work employing continuous type releases and where the ultimate buildup concentration is critical, a pre-determined method for measuring dye loss must be included as part of any such study.

A most important observation with regard to dye loss was the finding that the relationship before and after dye loss correction resulted in not only higher maxima values, but a plot of the before and after data exhibited parallelism. Consequently, any conclusions drawn from uncorrected dye data with regard to the various movements, as affected by flow and location, are valid.

The saving of time provided by employing the Analog Computer was most significant. Many months of detailed calculations would have been necessary over and above the time already spent on this report. As pointed out in the text, Dr. L. L. Falk of the duPont Company observed from his study work that the unimolecular equation fitted the characteristic buildup curve very well. Dr. Falk programmed the Analog Computer accordingly and the various rate constants for each location were quickly found. The advantages that can be derived by employing a computer should be considered as an integral part of any experimentation with models of tidal estuaries.

Part II - Potential Applications of Model Study Findings Toward Purification Capacity Evaluations

Application of the model study findings was undertaken in three different approaches. Namely, (a) development of formulae to characterize dispersion, (b) coordination of the organic matter stabilization with the changes in dye buildup as induced by changing of flow and, (c) coordination of the actual pollutional loadings and dispersion information with the objective of reproducing the waste concentration levels now existing in the prototype.

With regard to developing formulae, it was interesting to note that a plot of the rate coefficients developed from the computer at progressive locations formed a distinct pattern which is known as the "Gompertz Curve". Obviously, if such information did fit the Gompertz Curve or formula, the coefficients for intermediate locations could be obtained without further experimentation. Consequently, the Gompertz formula was programmed to the Computer and it was found to fit the data reasonably well. [The same approach was considered advisable for the ultimate buildup levels derived from the model studies. The curves formed by plotting the buildup concentrations at progressive points did show some similarity with the Gompertz Curve. However, when programmed in the Computer the data did not fit the formula. This observation conceivably may be changed by improved dye loss correction procedures. This aspect should be pursued vigorously by other investigators, as it appears highly probable a dispersion formula can be developed for concentration of conservative material. Time did not warrant investigating the matter further.]

Prototype studies, during the periods prior to the summer of 1960, indicated quite clearly that in portions of the Delaware estuary, particularly the lower reach, decreased water quality was evident during increased flow periods. Initially, it was assumed that only a temporary shift in quality occurred during the momentary increase of flow. A closer observation of the prototype data indicated that the shift or lowering of water quality in downstream areas was not of a tentative nature since the depressed quality persisted in the absence of periods of sudden precipitation, and the degree of depression remained in accordance with the fresh to salt water ratio established many days prior to measurement. Further, the prototype studies indicated that possibility of a "reversal" effect, in that, when sufficiently higher flows occurred, the quality would begin to show improvement. At the time, this change was attributed to the possibility that the dilution effect was exceeding or outstripping the detrimental effect as evidenced by decreased water quality. However, the prototype data with regard to the higher stages of flow were quite limited and the above observation remained purely an assumption.

The findings from the model studies presented the opportunity to evaluate the net change in concentration and transit time between any two given points during various flow stages. By use of the model, the river flow could be kept constant and would provide conditions comparable to controlled discharges upstream in a form of augmentation should reservoir development take place. It was readily apparent that increasing stages of flow resulted in lower buildup levels of the dye material. This is as expected since a conservative material should be present in lower concentrations at increased runoff. However, concurrently, as flow is increased, the time of transit between any two points is decreased. Pollutionwise, this loss of transit time would result in less time for stabilization of material between any two given locations, which may prove non-beneficial in specific areas. The problem, therefore, was to develop a procedure whereby the benefits derived from increasing flow could be balanced with the effect of the loss of waste stabilization time. The net improvement or loss of purification capacity at any given location under different conditions of temperature, stabilization rate and flow, were effectively presented in Chapter XVI. It can be seen how the water quality during the warmer and colder months could produce completely opposite effects at the same location.

In 1958, an inventory of waste discharges in the Delaware River was completed. This inventory was compiled by U. S. P. H. S. with the assistance of the States of New Jersey, Pennsylvania, Delaware and Incodel. The best available information was collected, however, a considerable portion of the loadings was estimated since time did not permit actual measurements of all discharges. Further, the information was presented on a 5-day BOD basis and not the ultimate oxygen demand requirements. The findings from this inventory were used in conjunction with the dispersion results obtained from the model study work.

Loadings were applied at the known points of discharge and into a hypothetical river system. The peaks of pollution agreed extremely well with the prototype findings, however, the concentration levels were materially less. Initially, it was assumed that the procedure employed could be in error. The method was re-evaluated carefully but no evidence could be found justifying a change. When a check was made of the amount of oxygen supplied by reaeration each day to the total river system, excluding that contributed by dilution and photosynthetic activity, it was immediately evident that the reported pollution loading inventory could conceivably be low. The amount of oxygen supplied by reaeration was further checked with the procedures of Imhoff and Fair (15), and that of Phelps (21), to confirm the fact that the oxygen entering the total river system each day far exceeded the recorded loadings converted to ultimate oxygen demand. Another approach was employed which further emphasized the importance of a more accurate inventory. Recorded loadings in the more heavily developed areas were doubled and the dispersion waste stabilization theory re-applied. It was found that by making this assumption, good agreement was obtained with the actual concentrations found in the prototype. Based upon the above evaluation, the States of New Jersey, Pennsylvania and Delaware agreed to make manometric measurements for the ultimate oxygen demand of all the major discharges entering the main stem of the Delaware River estuary.

In order to fully coordinate the findings, once the inventory is completed, all oxygen demanding material must balance with the various oxygen sources to the river system. Reasonably good information with regard to the oxygen supplied through accrual water, reaeration and photosynthesis, must be made available. Good estimates are possible for recording the oxygen supplied through dilution and that contributed by reaeration. However, no known work has been reported on the photosynthetic activity in the Delaware River estuary.

In the Spring of 1960, plans were considered for applying the procedure of Odum (20) to the upper Delaware River Estuary with the specific objective of establishing the approximate magnitude of photosynthetic activity. Finding a significant amount of respiratory oxygen could materially affect the approach taken toward establishing recovery capacity. In simple terms, a larger contribution from this source, coupled with the observed dissolved oxygen deficits, could imply extremely heavy loadings to the Delaware River far above all previous predictions. If the photosynthetic rates from other estuarine areas were applied to the Delaware River Basin, this source of oxygen would far exceed the combined contribution from dilution water and reaeration. As pointed out previously, the configuration and history of the Delaware River drainage basin differs sharply from other areas and it was therefore assumed photosynthetic activity must be appreciably less. The proof to confirm this assumption was, however, lacking.

Pollution studies (29) on the prototype were continued during the summer of 1960. The first "same slack" series samples of the season showed marked reductions and extensive depressed areas of dissolved oxygen when compared to previous years. This change was evident throughout the entire estuary except in the uppermost reach, above Fieldsboro. Two noteworthy changes were in evidence when compared to conditions of previous sampling periods.

Initially, we were experiencing a considerably wetter season, and as pointed out in Chapter XVI, increased flow should induce lower quality water in the lower reach of the estuary under specific conditions. This could not have been the entire season for the extensiveness of lower water quality simply because it has been shown increased flow improves the quality in upstream areas in contrast to the prototype findings.

The other change which had taken place was induced by the dredging operations conducted by the Corps of Engineers upstream from Allegheny Avenue. Deepening and widening of the river channel by jetting and blasting has resulted in a high (50-400 ppm) turbidity block from approximately Ben. Franklin Bridge to Florence, a distance of roughly 22 miles. This turbidity block was of sufficient concentration to prevent any photosynthetic activity in this area. The loss of this source of oxygen, coupled with effect of increased flow on water quality in the lower reach of the estuary, was in all probability the reason for the extensiveness of the overall depressed quality area, namely, from Florence to Reedy Island.

This dual effect of turbidity and flow was arrived at in an indirect manner. The effect of increasing flow was reasonably well established heretofore, and as pointed out previously, the oxygen contribution due to photosynthesis was assumed to be relatively minor. However, a sizeable respiratory source of oxygen would immediately imply larger pollutional loadings to the Delaware River. Besides, this loss of oxygen, due to turbidity, would have to be not only extremely large but universal to be of major significance to the total river. This concept of uniformity could not be accepted since turbidity contributions downstream from Ben. Franklin Bridge did not generally exceed the values of previous years. Therefore, the most logical explanation appeared to be that a dual effect of turbidity and flow were the controlling factors. Consequently, a series of measurements were made on the prototype and, coupled with previous findings, the magnitude of the oxygen supplied from plant activity between Florence and Ben. Franklin Bridge was approximated.

With the expressed purpose of confirming certain assumptions, a 24-hour study of dissolved oxygen, turbidity, and temperature was made downstream from Bristol, Pennsylvania, in the midst of the turbidity block. As anticipated, no apparent change in D.O. levels was evident between periods of bright sunlight and darkness. A similar series of measurements were made upstream from Fieldsboro where the effect of dredging was not evident. The findings showed significantly higher dissolved oxygen levels during sunlight, as compared to periods of darkness. The influence of adjacent marsh areas were evident as indicated by areas of supersaturation. As expected, photosynthetic activity was present in the less turbid areas.

It follows that if "same-slack" prototype measurements made during periods of high turbidity (1960) were compared with measurements of previous periods of similar temparature and flow, the difference could reasonably represent the magnitude of photosynthetic oxygen production in the high turbidity area.

The only available data for this comparison may be summarized as follows:

Date	Flow (Trenton)	Temp.	Slack Water
6/24/58	5,430 cfs	22°C	LWS
7/21/60	4,860 cfs	24°C	LWS

High and low water slack data are available for 7/21/60 but not for 6/24/58. However, the relationships are relative and the results comparable. Due to the wetness of the 1960 season, selections for comparison were limited. Consequently the calculations will be, of necessity, rough approximations. It must also be remembered, growth and development during the past two years could conceivably exert some influence.

Certain concepts with regard to the Delaware River Estuary warrant repetition at this point. The river system is essentially in a state of equilibrium. Under reasonably uniform flow, temperature, weather, and waste loadings, the resultant water quality will remain, for all practical considerations, stationary. Due to the times of transit between any two locations, characteristic of this estuary, equilibrium conditions represent from several days to several weeks of accumulation or buildup of pollutional loadings. Consequently, minor load fluctuations are not significant. Under reasonably stationary oxygen levels, reaeration will be dependent upon, and therefore calculated from, the degree of undersaturation.

From the D.O. deficits between the stations from Florence to Ben. Franklin Bridge on 6/24/58, an average rate of reaeration of 43.5% (29) in the presence of photosynthetic activity, coupled with the rate of flow during daylight hours, it may be calculated that approximately 221,491 lbs. of photosynthetic oxygen are produced within the above 21.87 mile stretch.

Within the area of the turbidity block, it may be noted from the 7/21/60 measurements, that a total of 690,227 lbs. of reaeration oxygen were supplied per day. Dilution oxygen was approximately equal on both dates and automatically cancels in this comparison. Reaeration oxygen has been estimated on 6/24/58 in this same section of river to approximate 468,736 lbs. per day. The difference of 221,491 lbs. represents the respiratory oxygen supply or loss during the high turbidity conditions. This appears sufficient to induce the depression of quality observed in the upper reach. Further, it appears the waste stabilization action lost due to the loss of photosynthetic oxygen is reflected as increased loadings or lower quality downstream.

This lowering of water quality downstream was not only evidenced by the depletion of oxygen in specific areas, but nitrate reduction (29) was also evident. A most significant observation may now be made. Growth and development upstream can conceivably be limited under the present status of waste loadings since serious water quality conditions resulted from a not too great a loss of oxygen on the basis of the total river capacity.

Dilution or accrual water in the upstream reach has been estimated at approximately 135,000 lbs. of oxygen per day. Consequently, the three major oxygen sources in this river reach, namely; accrual, respiration and reaeration, were found to contribute 16.3%, 26.8%, and 56.9% respectively, of the oxygen needed for stabilization. These percentages are notably different than the findings within the Chesapeake and Potomac Basin areas. An interesting comparison can be made with the observations of Garland (14) in the Baltimore Harbor area where he reported the contributions from accrual, respiration and reaeration sources as 20.4%, 54.4%, and 25.2% respectively. The photosynthesis and reaeration values are quite similar but reversed. It is conceivable that development in the Delaware River Basin has resulted in more extensive marsh destruction. It is clearly evident that additional study work is necessary with regard to the photosynthesis, particularly in downstream locations.

In order to have a complete balance sheet of the oxygen supplied from accrual, reaeration, and respiratory sources with oxygen demanding materials, a concentrated effort is needed not only to measure the pollution loadings from normal discharges, but to include those demands attributed to storm water overflow, benthal decomposition and plant life.

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APPENDIX

TABLE IX-1

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 1 H. W. S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station -100
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
7	.004	-	-	-							
9	.005	-	-	-							
11	.016	-	-	-							
13	.016	-	-	-							
14	-	.001	-	-							
15	.041	-	-	-							
16	-	.008	-	-							
17	.044	-	-	-							
18	-	.010	-	-							
19	.055	-	-	-							
20	-	.016	-	-							
21	.068	-	-	-							
22	-	.022	-	-							
23	.085	-	.001	-							
24	-	.033	-	-							
25	.094	-	.001	-							
26	-	.038	-	-							
27	.093	-	.004	-							
28	-	.045	-	-							
29	.114	-	.011	-							
30	-	.053	-	-							
31	-	-	.013	-							
32	.126	-	-	-	-						
33	-	-	.012	-	-						
34	-	.068	-	-	-						
35	-	-	.018	-	-						
36	.143	-	-	-	-						
37	-	-	.020	.003	-						
38	-	.088	-	-	-						
39	.129	-	-	-	-						
40	-	-	.024	.000	-						
41	-	.084	-	-	-						
42	.138	-	-	-	-						
43	-	-	.031	.004	-						
44	-	.094	-	-	-						
45	.142	-	-	-	-						
46	-	-	.043	.005	-						
47	-	.105	-	-	.001						
48	.117	-	-	-	-						
49	-	-	.050	.011	-						
50	-	.100	-	-	.000						
52	-	-	.050	.015	-						
53	-	-	-	-	.003						
54	.137	-	-	-	-						
55	-	-	.048	.015	-						
56	-	-	-	-	.008	.001					
57	-	-	.058	.018	-	-					
58	-	.110	-	-	-	.001					
59	-	-	-	.019	.004	-					
60	-	-	.066	-	-	.000					

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TABLE IX-1 (cont'd)

STATION NO.

Cycle No.	-60	-35	0	50	80	130	170	200	225	250	300
61	.123	-	-	-	.005	-					
62	-	-	-	.027	-	.000					
63	-	.114	-	-	.004	-					
64	-	-	.066	-	-	.003					
65	.147	-	-	.044	-	-					
66	-	.125	-	-	.014	-					
67	-	-	.064	-	-	.001	-				
68	.154	-	-	.028	-	-	-				
70	-	-	-	-	-	.003	-				
71	-	-	-	-	.012	-	-				
72	-	.113	.077	-	-	-	-				
73	-	-	-	.038	-	.004	-				
74	.174	-	-	-	-	-	-				
75	-	-	-	-	-	.002	-				
76	-	-	-	-	.020	-	-				
77	-	.138	.083	-	-	.003	-				
78	-	-	-	.038	-	-	-				
79	.174	-	-	-	-	.008	-				
80	-	-	.084	-	-	-	-				
81	-	-	-	-	.019	.009	-				
82	-	.157	-	-	-	-	.003				
83	-	-	-	.050	-	.005	-				
84	-	-	-	-	-	-	.001	-			
85	.182	-	.100	-	-	-	-	-			
86	-	-	-	-	.024	-	.000	-			
87	-	.160	-	-	-	.005	-	-			
89	-	-	-	.049	-	-	.003	.009			
90	-	-	.101	-	-	-	-	-			
91	-	-	-	-	.026	-	-	.002			
92	-	-	-	-	-	.007	.002	-			
93	-	-	-	-	-	-	-	.000			
94	-	-	-	.058	-	-	-	-			
95	.173	-	-	-	-	-	-	.002			
96	-	-	-	-	.037	-	.003	-			
97	-	.151	-	-	-	.010	-	.003			
99	-	-	-	.057	-	-	-	.000			
100	-	-	.111	-	-	-	-	-			
101	-	-	-	-	.039	-	.004	.000			
102	-	-	-	-	-	.008	-	-			
103	-	-	-	-	-	-	-	.002			
104	-	-	-	.067	-	-	-	-	-		
105	.166	-	-	-	-	-	-	.001	-		
106	-	-	-	-	.039	-	.007	-	-		
107	-	.149	-	-	-	..014	-	.005	-		
108	-	-	-	-	-	-	-	-	.001		
109	-	-	-	.058	-	-	-	.003	-		
110	-	-	.105	-	-	-	-	-	.001		
111	-	-	-	-	.044	-	.007	-	-		
112	-	-	-	-	-	.015	-	-	.004	-	
114	-	-	-	.072	-	-	-	.003	.003	-	
115	.179	-	-	-	-	-	-	-	-	-	
116	-	-	-	-	.048	-	.008	-	.002	-	
117	-	.153	-	-	-	.014	-	-	-	.002	
118	-	-	-	-	-	-	-	-	.002	-	
119	-	-	-	.066	-	-	-	.003	-	.003	

TABLE IX-1 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
120	-	-	.106	-	-	-	-	-	-	-	
121	-	-	-	-	.042	-	.009	-	-	.000	
122	-	-	-	-	-	.019	-	-	-	-	
123	-	-	-	-	-	-	-	-	.001	.001	
124	-	-	-	-	-	-	-	.004	-	-	
125	.140	-	-	-	-	-	-	-	-	.002	
126	-	-	-	-	.048	-	.007	-	-	-	
127	-	.165	-	-	-	.028	-	-	-	.004	
128	-	-	-	-	-	-	-	-	.002	-	
129	-	-	-	.078	-	-	-	.008	-	.002	
130	-	-	.125	-	-	.020	-	-	-	-	
131	-	-	-	-	.056	-	.011	-	-	-	
132	.145	-	-	.084	-	-	-	-	-	-	
133	-	.157	-	-	-	.024	-	-	-	-	
134	-	-	.117	-	-	-	.011	-	-	-	-
135	-	-	-	-	.056	-	-	-	-	-	-
136	-	-	-	-	-	-	-	.011	.012	-	-
137	-	-	-	.089	-	-	-	-	-	.008	.002
138	.152	-	-	-	-	.026	-	-	-	-	-
139	-	.166	-	-	-	-	.014	-	-	-	-
140	-	-	.124	-	-	-	-	.010	-	-	-
141	-	-	-	-	.050	-	-	-	.003	-	-
142	-	-	-	.085	-	-	-	-	-	-	.005
143	.187	-	-	-	-	.025	-	-	-	.003	-
144	-	.172	-	-	-	-	.017	-	-	-	-
145	-	-	.112	-	-	-	-	.008	-	-	-
146	-	-	-	-	.058	-	-	-	.007	-	-
147	-	-	-	.082	-	-	-	-	-	-	.004
148	-	-	-	-	-	.030	-	-	-	.053	-
149	-	.166	-	-	-	-	.012	-	-	-	-
150	-	-	.135	-	-	-	-	.008	-	-	-
151	-	-	-	-	.071	-	-	-	.004	-	-
152	-	-	-	.077	-	-	-	-	-	-	.009
153	.183	-	-	-	-	.032	-	-	-	.003	-
154	-	.155	-	-	-	-	.015	-	-	-	-
155	-	-	.138	-	-	-	-	.005	-	-	-
156	-	-	-	-	.066	-	-	-	.005	-	-
157	-	-	-	.099	-	-	-	-	-	-	.004
158	-	-	-	-	-	.030	-	-	-	.004	-
159	-	.165	-	-	-	-	.016	-	-	-	-
160	-	-	.135	-	-	-	-	.010	-	-	-
161	-	-	-	-	.073	-	-	-	.008	-	-
162	-	-	-	.043	-	-	-	-	-	-	.001
163	.175	-	-	-	-	.026	-	-	-	.002	-
164	-	.181	-	-	-	-	.018	-	-	-	-
165	-	-	.141	-	-	-	-	.010	-	-	-
166	-	-	-	-	.069	-	-	-	.008	-	-
167	-	-	-	.089	-	-	-	-	-	-	.004
168	-	-	-	-	-	.031	-	-	-	.004	-
169	-	.172	-	-	-	-	.018	-	-	-	-
170	-	-	.141	-	-	-	-	.010	-	-	-
171	-	-	-	-	.074	-	-	-	.008	-	-
172	-	-	-	.101	-	-	-	-	-	-	.001
173	.196	-	-	-	-	.032	-	-	-	.005	-
174	-	.177	-	-	-	-	.022	-	-	-	-
175	-	-	.128	-	-	-	-	.011	-	-	-
176	-	-	-	-	.077	-	-	-	.007	-	-
177	-	-	-	.106	-	-	-	-	-	-	.007
180	.162	.177	.138	.071	.083	.035	.022	.014	.012	.007	.003

TABLE IX-2
EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 1 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station -100
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
1	.021	-									
3	.028	-									
5	.047	-									
7	.064	-									
8	-	.019									
9	.100	-									
10	-	.032	-								
11	.110	-	-								
12	-	.051	-								
13	.125	-	.008								
14	-	.055	-								
15	.141	-	.009								
16	-	.077	-								
17	.103	-	.020								
18	-	.077	-								
19	.141	-	.026								
20	-	.093	-								
21	.169	-	-								
22	-	.112	-								
23	.169	-	.043								
24	-	.117	-								
25	.171	-	.043								
26	-	.114	-								
27	.177	-	.054								
28	-	.133	-	-							
29	.200	-	.062	-							
30	-	.141	-	-							
31	-	-	.070	.009							
32	.184	-	-	-							
33	-	-	.077	.010							
34	-	.156	-	-							
35	-	-	.073	.012	-						
36	.191	-	-	-	-						
37	-	-	.094	.016	-						
38	-	.171	-	-	.002						
39	.166	-	-	-	-						
40	-	-	.101	.022	-						
41	-	.162	-	-	.008						
42	.158	-	-	-	-						
43	-	-	.114	.030	-						
44	-	.145	-	-	.009						
45	.141	-	-	-	-						
46	-	-	.124	.033	-						
47	-	.142	-	-	.012						
48	.125	-	-	-	-	-					
49	-	-	.106	.037	-	-					
50	-	.127	-	-	.016	-					
51	-	-	-	-	-	.001					
52	-	-	.104	.043	-	-					

TABLE IX-2 (Cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
53	-	-	-	-	.016	.000					
54	.176	-	-	-	-	-					
55	-	-	.115	.043	-	-					
56	-	-	-	-	.022	.002					
57	-	-	.116	.049	-	-					
58	-	.156	-	-	-	.003					
59	-	-	-	.049	.023	-					
60	-	-	.114	-	-	.004					
61	.174	-	-	-	.019	-					
62	-	-	-	.061	-	.007					
63	-	.106	-	-	.020	-					
64	-	-	.127	-	-	.012					
65	.186	-	-	.057	-	-					
66	-	.158	-	-	.030	-					
67	-	-	.125	-	-	.010					
68	.189	-	-	.065	-	-					
70	-	-	-	-	-	.014					
71	-	-	-	-	.038	-					
72	-	.173	.136	-	-	-					
73	-	-	-	.064	-	.013					
74	.225	-	-	-	-	-					
75	-	-	-	-	-	.014					
76	-	-	-	-	.043	-					
77	-	.184	.153	-	-	.014					
78	-	-	-	.079	-	-					
79	.196	-	-	-	-	.020	-				
80	-	-	.152	-	-	-	-				
81	-	-	-	-	.048	.024	-				
82	-	.185	-	-	-	-	.007				
83	-	-	-	.092	-	.021	-				
84	-	-	-	-	-	-	.007				
85	.165	-	.162	-	-	-	-	-			
86	-	-	-	-	.059	-	.007	-			
87	-	.187	-	-	-	.023	-	-			
89	-	-	-	.090	-	-	.008	.009			
90	-	-	.155	-	-	-	-	-			
91	-	-	-	-	.055	-	-	.002			
92	-	-	-	-	-	.020	.012	-			
93	-	-	-	-	-	-	-	.003			
94	-	-	-	.103	-	-	-	-			
95	. 192	-	-	-	-	-	-	.004			
96	-	-	-	-	.067	-	.013	-			
97	-	.172	-	-	-	.031	-	.008			
99	-	-	-	.104	-	-	-	.004			
100	-	-	.159	-	-	-	-	-			
101	-	-	-	-	.067	-	.013	.004			
102	-	-	-	-	-	.033	-	-			
103	-	-	-	-	-	-	-	.005			
104	-	-	-	.100	-	-	-	-			
105	. 192	-	-	-	-	-	-	.007	-		
106	-	-	-	-	. 071	-	.019	-	-		
107	-	.166	-	-	-	.034	-	. 012	-		
108	-	-	-	-	-	-	-	-	.004		
109	-	-	-	.107	-	-	-	. 008	-		
110	-	-	.138	-	-	-	-	-	.004		
111	-	-	-	-	.077	-	.018	-	-		

TABLE IX-2 (cont'd)

Cycle No.	STATION NO.										
	-60	-35	0	50	80	130	170	200	225	250	300
112	-	-	-	-	-	.034	-	-	.011		
114	-	-	-	.102	-	-	-	.010	.005	-	
115	.189	-	-	-	-	-	-	-	-	-	
116	-	-	-	-	.072	-	.019	-	.008	-	
117	-	.139	-	-	-	.042	-	-	-	.004	
118	-	-	-	-	-	-	-	-	.005	-	
119	-	-	-	.113	-	-	-	.009	-	.003	
120	-	-	.168	-	-	-	-	-	-	-	
121	-	-	-	-	.082	-	.023	-	-	.002	
122	-	-	-	-	-	.046	-	-	-	-	
123	-	-	-	-	-	-	-	-	.008	.002	
124	-	-	-	-	-	-	-	.011	-	-	
125	.194	-	-	-	-	-	-	-	-	.003	
126	-	-	-	-	.079	-	.020	-	-	-	
127	-	.189	-	-	-	.050	-	-	-	.008	
128	-	-	-	-	-	-	-	-	.008	-	
129	-	-	-	.118	-	-	-	.016	-	.003	
130	-	-	.166	-	-	.046	-	-	-	-	
131	-	-	-	-	.085	-	.027	-	-	-	
132	.187	-	-	.115	-	-	-	-	-	-	
133	-	.188	-	-	-	.058	-	-	-	-	
134	-	-	.164	-	-	-	.025	-	-	-	-
135	-	-	-	-	.080	-	-	-	-	-	-
136	-	-	-	-	-	-	-	.016	.012	-	-
137	-	-	-	.122	-	-	-	-	-	.008	.002
138	.197	-	-	-	-	.054	-	-	-	-	-
139	-	.186	-	-	-	-	.031	-	-	-	-
140	-	-	.170	-	-	-	-	.023	-	-	-
141	-	-	-	-	.087	-	-	-	.011	-	-
142	-	-	-	.123	-	-	-	-	-	-	.005
143	.188	-	-	-	-	.060	-	-	-	.008	-
144	-	.186	-	-	-	-	.031	-	-	-	-
145	-	-	.158	-	-	-	-	.019	-	-	-
146	-	-	-	-	.093	-	-	-	.013	-	-
147	-	-	-	.111	-	-	-	-	-	-	.000
148	-	-	-	-	-	.055	-	-	-	.008	-
149	-	.181	-	-	-	-	.033	-	-	-	-
150	-	-	.169	-	-	-	-	.016	-	-	-
151	-	-	-	-	.100	-	-	-	.013	-	-
152	-	-	-	.118	-	-	-	-	-	-	.011
153	.177	-	-	-	-	.056	-	-	-	.007	-
154	-	.187	-	-	-	-	.033	-	-	-	-
155	-	-	.164	-	-	-	-	.005	-	-	-
156	-	-	-	-	.097	-	-	-	.013	-	-
157	-	-	-	.113	-	-	-	-	-	-	.004
158	-	-	-	-	-	.060	-	-	-	.008	-
159	-	.181	-	-	-	-	.036	-	-	-	-
160	-	-	.168	-	-	-	-	.023	-	-	-
161	-	-	-	-	.100	-	-	-	.015	-	-
162	-	-	-	.106	-	-	-	-	-	-	.003
163	.187	-	-	-	-	.066	-	-	-	.011	-
164	-	.173	-	-	-	-	.035	-	-	-	-
165	-	-	.176	-	-	-	-	.023	-	-	-
166	-	-	-	-	.095	-	-	-	.018	-	-
167	-	-	-	.118	-	-	-	-	-	-	.003
168	-	-	-	-	-	.071	-	-	-	.009	-

TABLE IX-2 (cont'd)

STATION NO.

Cycle No.	-60	-35	0	50	80	130	170	200	225	225	300
169	-	.196	-	-	-	-	.035	-	-	-	-
170	-	-	.180	-	-	-	-	.022	-	-	-
171	-	-	-	-	.101	-	-	-	.016	-	-
172	-	-	-	.127	-	-	-	-	-	-	.004
173	.183	-	-	-	-	.068	-	-	-	.009	-
174	-	.184	-	-	-	-	.039	-	-	-	-
175	-	-	.175	-	-	-	.025	-	-	-	-
176	-	-	-	-	.108	-	-	-	.020	-	-
177	-	-	-	.138	-	-	-	-	-	-	.004
180	.197	.193	.140	.101	.088	.066	.032	.022	.018	.012	.005

TABLE IX-3

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 2 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station 0+00
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

STATION NO.

Cycle No.	-60	-35	0	50	80	130	170	200	225	250	300
2	-	.012	.002	-	-						
4	-	.045	.013	.003	-						
5	-	.035	-	-	.000						
6	-	-	.016	.001	-						
7	-	.034	-	-	.000						
8	.001	-	.033	.000	-						
9	-	.049	-	-	.000						
10	.003	-	.043	.002	-						
11	-	.053	-	-	.000						
12	.002	-	.044	.004	-						
13	-	.058	-	-	.000						
14	.004	-	.058	.008	-						
15	-	.060	-	-	.001						
16	.004	-	.067	.010	-						
17	-	.064	-	-	.001						
18	.007	-	.073	.014	-						
19	-	.058	-	-	.001						
20	.007	-	.079	.016	-						
21	-	.059	-	-	.001						
22	.005	-	.087	.021	-						
23	-	.069	-	-	.003						
24	.005	-	-	.021	-						
25	-	-	.091	-	.005	-					
26	-	.060	-	.025	-	-					
27	.007	-	-	-	.007	-					
28	-	-	.090	-	-	.000					
29	-	.069	-	.028	-	-					
30	.008	-	-	-	.012	-					
31	-	-	.099	-	-	.001					
32	-	.081	-	.042	-	-					

TABLE IX-3 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
33	.008	-	-	-	.013	-					
34	-	-	.104	-	-	.000					
35	-	.069	-	.036	-	-					
36	.010	-	-	-	.021	-					
37	-	-	.107	-	-	.001					
38	-	.082	-	.055	-	-					
39	.010	-	-	-	.048	-					
40	-	-	.122	-	-	.001					
41	-	.090	-	.047	-	-					
42	.008	-	-	-	.024	-					
43	-	-	.094	-	-	.005					
44	-	.080	-	-	-	-					
45	.005	-	-	.058	-	-	-				
46	-	-	.114	-	.035	-	-				
47	-	.091	-	-	-	.007	-				
48	.009	-	-	-	-	-	.002				
49	-	-	.125	.048	-	-	-				
50	-	.096	-	-	.025	-	-				
51	.009	-	-	-	-	.008	-				
52	-	-	.123	-	-	-	.004				
53	-	.096	-	.073	-	-	-				
54	.008	-	-	-	.035	-	-				
55	-	-	.130	-	-	.012	-				
56	-	.083	-	-	-	-	.003				
57	.008	-	-	.077	-	-	-				
58	-	-	.117	-	.033	-	-				
59	-	.099	-	-	-	.011	-				
60	.011	-	-	-	-	-	.004				
61	-	-	.137	.077	-	-	-				
62	-	.094	-	-	.037	-	-	-			
63	.012	-	-	-	-	.014	-	-			
64	-	-	.136	-	-	-	.005	-			
65	-	.062	-	-	-	-	-	.003			
66	.008	-	-	.081	-	-	-	-			
67	-	-	.143	-	.049	-	-	-			
68	-	.081	-	-	-	.013	-	-			
69	.008	-	-	.091	-	-	.009	-			
70	-	-	.148	-	-	-	-	.003			
71	-	.095	-	-	.034	-	-	-			
72	.007	-	-	-	-	-	-	-			
73	-	-	-	.081	-	.015	-	-			
74	-	-	.126	-	-	-	.013	-			
75	-	.099	-	-	-	-	-	.005			
76	.010	-	-	-	-	-	-	-			
77	-	-	-	-	.058	-	-	-			
78	-	-	-	.094	-	.018	-	-	-		
79	-	-	.133	-	-	-	.012	-	-		
80	-	.094	-	-	-	-	-	.003	-		
81	.010	-	-	-	-	-	-	-	.005		
82	-	-	-	-	.066	-	-	-	-		
83	-	-	-	.099	-	.012	-	-	-		
84	-	-	.150	-	-	-	.012	-	-	-	
85	-	.096	-	-	-	-	-	.004	-	-	
86	.015	-	-	-	-	-	-	-	.005	-	
87	-	-	-	-	.067	-	-	-	-	.004	
88	-	-	-	.100	-	.026	-	-	-	-	

TABLE IX-3 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
89	-	-	.107	-	-	-	.011	-	-	-	
90	-	.108	-	-	-	-	-	.003	-	-	
91	.015	-	-	-	-	-	-	-	.008	-	
92	-	-	-	-	.067	-	-	-	-	.002	
93	-	-	-	.101	-	.026	-	-	-	-	
94	-	-	.146	-	-	-	.012	-	-	-	
95	-	-	-	-	-	-	-	.007	-	-	
96	.008	-	-	-	-	-	-	-	.010	-	
97	-	-	-	-	.073	-	-	-	-	.000	
98	-	.107	-	.091	-	.027	-	-	-	-	
99	-	-	.160	-	-	-	.013	-	-	-	
100	-	.097	-	-	-	-	-	.005	-	-	
101	.013	-	-	-	-	-	-	-	.008	-	
102	-	-	-	-	.079	-	-	-	-	.004	
103	-	-	-	.104	-	.027	-	-	-	-	
104	-	-	.186	-	-	-	.019	-	-	-	
105	-	.108	-	-	-	-	-	.008	-	-	
106	.013	-	-	-	-	-	-	-	.007	-	
107	-	-	-	-	.073	-	-	-	-	.003	
108	-	-	-	.111	-	.032	-	-	-	-	
109	-	-	.161	-	-	-	.021	-	-	-	
110	-	.106	-	-	-	-	-	.012	-	-	
111	.014	-	-	-	-	-	-	-	.004	-	
112	-	-	-	-	.084	-	-	-	-	.000	
113	-	-	-	.116	-	.035	-	-	-	-	
114	-	-	.146	-	-	-	.069	-	-	-	
115	-	.112	-	-	-	-	-	.010	-	-	
116	.014	-	-	-	-	-	-	-	.008	-	
117	-	-	-	-	.078	-	-	-	-	.004	
118	-	-	-	.118	-	.036	-	-	-	-	
119	-	-	.163	-	-	-	.024	-	-	-	
120	-	.103	-	-	-	-	-	.014	-	-	
121	.011	-	-	-	-	-	-	-	.008	-	
122	-	-	-	-	.080	-	-	-	-	.003	
123	-	-	-	.118	-	.043	-	-	-	-	
124	-	-	.163	-	-	-	.025	-	-	-	
125	-	.099	-	-	-	-	-	.013	-	-	-
126	.014	-	-	-	-	-	-	-	.067	-	-
127	-	-	-	-	.083	-	-	-	-	.004	-
128	-	-	-	.117	-	.042	-	-	-	-	.003
129	-	-	.153	-	-	-	.028	-	-	-	-
130	-	.093	-	-	-	-	-	.013	-	-	-
131	.014	-	-	-	-	-	-	-	.008	-	-
132	-	-	-	-	.095	-	-	-	-	.005	-
133	-	-	-	.114	-	.039	-	-	-	-	.003
134	-	-	.143	-	-	-	.021	-	-	-	-
135	-	.090	-	-	-	-	-	.013	-	-	-
136	.015	-	-	-	-	-	-	-	.007	-	-
137	-	-	-	-	.095	-	-	-	-	.004	-
138	-	-	-	.117	-	.047	-	-	-	-	.000
139	-	-	.140	-	-	-	.022	-	-	-	-
140	-	.060	-	-	-	-	-	.014	-	-	-
141	.009	-	-	-	-	-	-	-	.008	-	-
142	-	-	-	-	.100	-	-	-	-	.004	-
143	-	-	-	.119	-	.050	-	-	-	-	.001
144	-	-	.151	-	-	-	.027	-	-	-	-

TABLE IX-3 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
145	-	.101	-	-	-	-	-	.015	-	-	-
146	.008	-	-	-	-	-	-	-	.010	-	-
147	-	-	-	-	.091	-	-	-	-	.007	-
148	-	-	-	.124	-	.046	-	-	-	-	.003
149	-	-	.155	-	-	-	.030	-	-	-	-
150	-	.097	-	-	-	-	-	.015	-	-	-
151	.010	-	-	-	-	-	-	-	.010	-	-
152	-	-	-	-	.092	-	-	-	-	.008	-
153	-	-	-	.122	-	.053	-	-	-	-	.002
154	-	-	.146	-	-	-	.019	-	-	-	-
155	-	.084	-	-	-	-	-	.015	-	-	-
156	.012	-	-	-	-	-	-	-	.009	-	-
157	-	-	-	-	.076	-	-	-	-	.008	-
158	-	-	-	.120	-	.055	-	-	-	-	.004
159	-	-	.136	-	-	-	.032	-	-	-	-
160	-	.084	-	-	-	-	-	.020	-	-	-
161	.011	-	-	-	-	-	-	-	.010	-	-
162	-	-	-	-	.082	-	-	-	-	.008	-
163	-	-	-	.119	-	.054	-	-	-	-	.001
164	-	-	.163	-	-	-	.031	-	-	-	-
165	-	.096	-	-	-	-	-	.015	-	-	-
166	.010	-	-	-	-	-	-	-	.011	-	-
167	-	-	-	-	.091	-	-	-	-	.004	-
168	-	-	-	.124	-	.054	-	-	-	-	.002
169	-	-	.123	-	-	-	.065	-	-	-	-
170	-	.093	-	-	-	-	-	.020	-	-	-
171	.009	-	-	-	-	-	-	-	.009	-	-
172	-	-	-	-	.073	-	-	-	-	.008	-
173	-	-	-	.128	-	-	-	-	-	-	.001
174	-	-	.135	-	-	-	.028	-	-	-	-
175	-	.084	-	-	-	-	-	.018	-	-	-
176	.010	-	-	-	-	-	-	-	.013	-	-
177	-	-	-	-	.100	-	-	-	-	.005	-
178	-	-	-	.119	-	.050	-	-	-	-	.002
179	-	-	.142	-	-	-	.028	-	-	-	-
180	.015	.081	.166	.126	.125	.058	.034	.022	.012	.010	.004

TABLE IX-4
EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 2 L.W.S. CONCENTRATION READING EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station 0+00
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
2	-	.000	.010	.001	-						
4	-	.002	.023	.005	-						
5	-	.000	-	-	.000						
6	-	-	.019	.012	-						
7	-	.001	-	-	.000						

TABLE IX-4 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
8	.000	-	.025	.019	-						
9	-	.001	-	-	.001						
10	.001	-	.031	.028	-						
11	-	.001	-	-	.004						
12	.000	-	.032	.035	-						
13	-	.000	-	-	.002						
14	.001	-	.043	.045	-						
15	-	.001	-	-	.009						
16	.001	-	.034	.045	-						
17	-	.003	-	-	.014						
18	.001	-	.041	.038	-						
19	-	.001	-	-	.011						
20	.000	-	.046	.046	-						
21	-	.003	-	-	.014						
22	.000	-	.039	.064	-						
23	-	.004	-	-	.019						
24	.000	-	-	.076	-						
25	-	-	.046	-	.022	-					
26	-	.002	-	.077	-	-					
27	.000	-	-	-	.031	-					
28	-	-	.046	-	-	.009					
29	-	.007	-	.080	-	-					
30	.000	-	-	-	.035	-					
31	-	-	.054	-	-	.011					
32	-	.003	-	.074	-	-					
33	.000	-	-	-	.039	-					
34	-	-	.046	-	-	.011					
35	-	.004	-	.070	-	-					
36	.001	-	-	-	.054	-	-				
37	-	-	.050	-	-	.014	-				
38	-	.004	-	.096	-	-	-				
39	.000	-	-	-	-	-	.005				
40	-	-	.069	-	-	.015	-				
41	-	.004	-	.104	-	-	-				
42	.000	-	-	-	.055	-	-				
43	-	-	.059	-	-	.020	-				
44	-	.003	-	-	-	-	.004				
45	.003	-	-	.114	-	-	-				
46	-	-	.067	-	.060	-	-				
47	-	.005	-	-	-	.027	-				
48	.000	-	-	-	-	-	.009				
49	-	-	.068	.106	-	-	-				
50	-	.004	-	-	.072	-	-	-			
51	.001	-	-	-	-	.030	-	-			
52	-	-	.061	-	-	-	.012	-			
53	-	.004	-	.120	-	-	-	.004			
54	.000	-	-	-	.072	-	-	-			
55	-	-	.061	-	-	.032	-	-			
56	-	.007	-	-	-	-	.012	-			
57	.000	-	-	.106	-	-	-	-			
58	-	-	.066	-	.076	-	-	-			
59	-	.009	-	-	-	.031	-	-			
60	.000	-	-	-	-	-	.015	.007			
61	-	-	.072	.113	-	-	-	-			
62	-	.012	-	-	.070	-	-	-			
63	.000	-	-	-	-	.042	-	-			

TABLE IX-4 (cont'd)

Cycle No.	STATION NO.										
	-60	-35	0	50	80	130	170	200	225	250	300
64	-	-	.072	-	-	-	.014	-			
65	-	.000	-	-	-	-	-	.009			
66	.000	-	-	.134	-	-	-	-			
67	-	-	.071	-	.085	-	-	-			
68	-	.008	-	-	-	.045	-	-			
69	.000	-	-	.129	-	-	.025	-			
70	-	-	.061	-	-	-	-	.011			
71	-	.008	-	-	.084	-	-	-			
72	.000	-	-	-	-	-	-	-			
73	-	-	-	.130	-	.046	-	-			
74	-	-	.064	-	-	-	.026	-			
75	-	.005	-	-	-	-	-	.008			
76	.001	-	-	-	-	-	-	-			
77	-	-	-	-	.088	-	-	-			
78	-	-	-	.135	-	.050	-	-	-		
79	-	-	.062	-	-	-	.030	-	-		
80	-	.007	-	-	-	-	-	.013	-		
81	.000	-	-	-	-	-	-	-	.012		
82	-	-	-	-	.096	-	-	-	-		
83	-	-	-	.133	-	.050	-	-	-		
84	-	-	.066	-	-	-	.033	-	-	-	
85	-	.008	-	-	-	-	-	.021	-	-	
86	.001	-	-	-	-	-	-	-	.010	-	
87	-	-	-	-	.110	-	-	-	-	.007	
88	-	-	-	.135	-	.060	-	-	-	-	
89	-	-	.071	-	-	-	.033	-	-	-	
90	-	.008	-	-	-	-	-	.012	-	-	
91	.001	-	-	-	-	-	-	-	.011	-	
92	-	-	-	-	.104	-	-	-	-	.003	
93	-	-	-	.146	-	.062	-	-	-	-	
94	-	-	.074	-	-	-	.035	-	-	-	
95	-	.008	-	-	-	-	-	.018	-	-	
96	.000	-	-	-	-	-	-	-	.013	-	
97	-	-	-	-	.116	-	-	-	-	.005	
98	-	-	-	.140	-	.064	-	-	-	-	
99	-	-	.071	-	-	-	.038	-	-	-	
100	-	.004	-	-	-	-	-	.014	-	-	
101	.000	-	-	-	-	-	-	-	.018	-	
102	-	-	-	-	.107	-	-	-	-	.009	
103	-	-	-	.146	-	.069	-	-	-	-	
104	-	-	.065	-	-	-	.043	-	-	-	
105	-	.005	-	-	-	-	-	.020	-	-	
106	.000	-	-	-	-	-	-	-	.015	-	
107	-	-	-	-	.120	-	-	-	-	.010	
108	-	-	-	.152	-	.073	-	-	-	-	
109	-	-	.070	-	-	-	.044	-	-	-	
110	-	.008	-	-	-	-	-	.021	-	-	
111	.000	-	-	-	-	-	-	-	.014	-	
112	-	-	-	-	.110	-	-	-	-	.004	
113	-	-	-	.152	-	.072	-	-	-	-	
114	-	-	.072	-	-	-	.044	-	-	-	
115	-	.005	-	-	-	-	-	.024	-	-	
116	.000	-	-	-	-	-	-	-	.020	-	
117	-	-	-	-	.116	-	-	-	-	.010	
118	-	-	-	.149	-	.070	-	-	-	-	

TABLE IX-4 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
119	-	-	.062	-	-	-	.050	-	-	-	
120	-	.004	-	-	-	-	-	.028	-	-	
121	.000	-	-	-	-	-	-	-	.020	-	
122	-	-	-	-	.113	-	-	-	-	.011	
123	-	-	-	.151	-	.071	-	-	-	-	
124	-	-	.065	-	-	-	.049	-	-	-	
125	-	.004	-	-	-	-	-	.027	-	-	-
126	.000	-	-	-	-	-	-	-	.020	-	-
127	-	-	-	-	.124	-	-	-	-	.010	-
128	-	-	-	.146	-	.084	-	-	-	-	.004
129	-	-	.061	-	-	-	.054	-	-	-	-
130	-	.003	-	-	-	-	-	.027	-	-	-
131	.000	-	-	-	-	-	-	-	.014	-	-
132	-	-	-	-	.124	-	-	-	-	.012	-
133	-	-	-	.159	-	.088	-	-	-	-	.005
134	-	-	.065	-	-	-	.048	-	-	-	-
135	-	.002	-	-	-	-	-	.026	-	-	-
136	-	-	-	-	-	-	-	-	.020	-	-
137	-	-	-	-	.111	-	-	-	-	.013	-
138	-	-	-	.150	-	.074	.049	-	-	-	.002
139	-	-	.067	-	-	-	-	-	-	-	-
140	-	.003	-	-	-	-	-	.034	-	-	-
141	.000	-	-	-	-	-	-	-	.025	-	-
142	-	-	-	-	.128	-	-	-	-	.012	-
143	-	-	-	.136	-	.090	-	-	-	-	.003
144	-	-	.069	-	-	-	.048	-	-	-	-
145	-	.005	-	-	-	-	-	.031	-	-	-
146	.000	-	-	-	-	-	-	-	.027	-	-
147	-	-	-	-	.116	-	-	-	-	.014	-
148	-	-	-	.118	-	.089	-	-	-	-	.005
149	-	-	.058	-	-	-	.047	-	-	-	-
150	-	.002	-	-	-	-	-	.031	-	-	-
151	.000	-	-	-	-	-	-	-	.016	-	-
152	-	-	-	-	.130	-	-	-	-	.015	-
153	-	-	-	.150	-	.094	-	-	-	-	.007
154	-	-	.069	-	-	-	.047	-	-	-	-
155	-	.007	-	-	-	-	-	.033	-	-	-
156	.000	-	-	-	-	-	-	-	.027	-	-
157	-	-	-	-	.128	-	-	-	-	.016	-
158	-	-	-	.135	-	.090	-	-	-	-	.007
159	-	-	.076	-	-	-	.056	-	-	-	-
160	-	.003	-	-	-	-	-	.039	-	-	-
161	.000	-	-	-	-	-	-	-	.025	-	-
162	-	-	-	-	.122	-	-	-	-	.015	-
163	-	-	-	.145	-	.091	-	-	-	-	.007
164	-	-	.078	-	-	-	.058	-	-	-	-
165	-	.005	-	-	-	-	-	.036	-	-	-
166	.000	-	-	-	-	-	-	-	.026	-	-
167	-	-	-	-	.111	-	-	-	-	.014	-
168	-	-	-	.154	-	-	-	-	-	-	.005
169	-	-	.076	-	-	-	.050	-	-	-	-
170	-	.004	-	-	-	-	-	.038	-	-	-
171	.000	-	-	-	-	-	-	-	.028	-	-
172	-	-	-	-	.115	-	-	-	-	.018	-
173	-	-	-	.147	-	.090	-	-	-	-	.007
174	-	-	.096	-	-	-	.056	-	-	-	-

TABLE IX-4 (cont'd)

Cycle No.	STATION NO. -60	-35	0	50	80	130	170	200	225	250	300
175	-	.007	-	-	-	-	-	.042	-	-	-
176	.000	-	-	-	-	-	-	-	.031	-	-
177	-	-	-	-	.123	-	-	-	-	.016	-
178	-	-	-	.123	-	.090	-	-	-	-	.007
179	-	-	.064	-	-	-	-	-	-	-	-
180	.001	.004	.128	.147	.092	.089	.064	.041	.028	.014	.008

TABLE IX-5

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 3 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. -35	0	50	80	130	170	200	225	250	300
1	-	-	-	.001						
2	-	-	.003	-	-					
3	-	-	-	.001	-					
4	-	.003	.012	-	-					
5	-	-	-	.003	.000					
6	-	.004	.020	-	-					
7	-	-	-	.003	.001					
8	-	.005	.028	-	-					
9	-	-	-	.004	.002					
10	-	.011	.033	-	-					
11	-	-	-	.077	-	-				
12	-	-	.042	.009	-	-				
13	-	.019	-	-	.002	-				
14	-	-	.049	-	-	.000				
15	-	.020	-	.012	-	-				
16	-	-	.045	-	.002	-				
17	-	.021	-	-	-	.001				
18	.001	-	-	.016	-	-				
19	-	-	.058	-	.003	-				
20	-	.023	-	-	-	.000				
21	.001	-	-	.018	-	-				
22	-	-	.065	-	.004	-				
23	-	.026	-	-	-	.002				
24	.001	-	-	-	-	-	-			
25	-	-	.065	-	.005	-	-	-		
26	-	.030	-	-	-	.001	-	-		
27	.002	-	-	-	-	-	.001	-		
28	-	-	.067	-	-	-	-	.002		
29	-	.030	-	.027	-	-	-	-		
30	.003	-	-	-	.010	-	-	-		
31	-	-	-	-	-	.002	-	-	-	
32	-	-	.079	-	-	-	.002	-	-	
33	-	.036	-	-	-	-	-	.001	-	
34	.004	-	-	-	-	-	-	-	.000	

TABLE IX-5 (cont'd)

Cycle No.	STATION NO. -35	0	50	80	130	170	200	225	250	300
35	-	-	-	.046	.012	-	-	-	-	
36	-	-	.076	-	-	.003	-	-	-	
37	-	.046	-	-	-	-	.002	-	-	
38	.005	-	-	-	-	-	-	.002	-	
39	-	-	-	.045	-	-	-	-	.002	
40	-	-	.084	-	.014	-	-	-	-	
41	-	.043	-	-	-	.008	-	-	-	
42	.008	-	-	-	-	-	.001	-	-	
43	-	-	-	.050	-	-	-	.002	-	
44	-	-	.077	-	-	-	-	-	.002	
45	-	.044	-	-	.015	-	-	-	-	
46	.007	-	-	-	-	.008	-	-	-	
47	-	-	-	.058	-	-	.007	-	-	
48	-	-	.093	-	-	-	-	.002	-	
49	-	.035	-	-	-	-	-	-	.001	
50	.008	-	-	-	.015	-	-	-	-	
51	-	-	-	.064	-	.009	-	-	-	
52	-	-	.107	-	-	-	.003	-	-	
53	-	.047	-	-	-	-	-	.000	-	
54	.008	-	-	-	-	-	-	-	.004	
55	-	-	-	.068	.021	-	-	-	-	
56	-	-	.108	-	-	.011	-	-	-	
57	-	.048	-	-	-	-	.005	-	-	
58	.008	-	-	-	-	-	-	-	-	
59	-	-	-	.077	-	-	-	-	.003	
60	-	-	.107	-	.026	-	-	-	-	
61	-	.050	-	-	-	.012	-	-	-	
62	.009	-	-	-	-	-	.005	-	-	
63	-	-	-	.069	-	-	-	.004	-	
64	-	-	.116	-	-	-	-	-	.003	
65	-	.061	-	-	.031	-	-	-	-	
66	.009	-	-	-	-	.014	-	-	-	
67	-	-	-	.083	-	-	.008	-	-	
68	-	-	.125	-	-	-	-	.004	-	
69	-	.067	-	-	-	-	-	-	.003	
70	.002	-	-	-	.030	-	-	-	-	
71	-	-	-	.089	-	.015	-	-	-	
72	-	-	.123	-	-	-	.009	-	-	
73	-	.062	-	-	-	-	-	.005	-	
74	.008	-	-	-	-	-	-	-	.005	
75	-	-	-	.112	.033	-	-	-	-	
76	-	-	.126	-	-	.015	-	-	-	
77	-	.058	-	-	-	-	.010	-	-	
78	.011	-	-	-	-	-	-	.007	-	
79	-	-	-	.082	-	-	-	-	.004	
80	-	-	.107	-	-	-	-	-	-	
81	-	.061	-	-	.039	-	-	-	-	
82	.011	-	-	-	-	.021	-	-	-	
83	-	-	-	.082	-	-	.009	-	-	-
84	-	-	.159	-	-	-	-	.007	-	-
85	-	.077	-	-	-	-	-	-	.004	-
86	.008	-	-	-	.043	-	-	-	-	.001
87	-	-	-	.095	-	.021	-	-	-	-
88	-	-	.123	-	-	-	.012	-	-	-
89	-	.064	-	-	-	-	-	.010	-	-
90	.003	-	-	-	-	-	-	-	.005	-

TABLE IX-5 (cont'd)

Cycle No.	STATION NO. -35	0	50	80	130	170	200	225	250	300
91	-	-	-	.100	.045	-	-	-	-	.001
92	-	-	.138	-	-	.021	-	-	-	-
93	-	.065	-	-	-	-	.012	-	-	-
94	.007	-	-	-	-	-	-	.009	-	-
95	-	-	-	.094	-	-	-	-	.004	-
96	-	-	.131	-	.038	-	-	-	-	.001
97	-	.050	-	-	-	.023	-	-	-	-
98	.014	-	-	-	-	-	.012	-	-	-
99	-	-	-	.112	-	-	-	.008	-	-
100	-	-	.106	-	-	-	-	-	.004	-
101	-	.058	-	-	.046	-	-	-	-	.001
102	.011	-	-	-	-	.026	-	-	-	-
103	-	-	-	.093	-	-	.013	-	-	-
104	-	-	.143	-	-	-	-	.008	-	-
105	-	.066	-	-	-	-	-	-	.004	-
106	.010	-	-	-	.051	-	-	-	-	.003
107	-	-	-	.097	-	.028	-	-	-	-
108	-	-	.181	-	-	-	.015	-	-	-
109	-	.060	-	-	-	-	-	.009	-	-
110	.009	-	-	-	-	-	-	-	.005	-
111	-	-	-	.095	.056	-	-	-	-	.001
112	-	-	.136	-	-	.030	-	-	-	-
113	-	.070	-	-	-	-	.015	-	-	-
114	.008	-	-	-	-	-	-	.012	-	-
115	-	-	-	.105	-	-	-	-	.005	-
116	-	-	.134	-	.054	-	-	-	-	.003
117	-	.070	-	-	-	.032	-	-	-	-
118	.007	-	-	-	-	-	.015	-	-	-
119	-	-	-	.104	-	-	-	.010	-	-
120	-	-	.119	-	-	-	-	-	.008	-
121	-	.068	-	-	.058	-	-	-	-	.003
122	.002	-	-	-	-	.031	-	-	-	-
123	-	-	-	.112	-	-	.016	-	-	-
124	-	-	.117	-	-	-	-	.009	-	-
125	-	.065	-	-	-	-	-	-	.007	-
126	.011	-	-	-	.060	-	-	-	-	.002
127	-	-	-	.104	-	.033	-	-	-	-
128	-	-	.142	-	-	-	.019	-	-	-
129	-	.059	-	-	-	-	-	.011	-	-
130	.012	-	-	-	-	-	-	-	.009	-
131	-	-	-	-	-	-	-	-	-	.002
132	-	-	.135	-	.058	.036	-	-	-	-
133	-	.071	-	-	-	-	-	-	-	-
134	.013	-	-	-	-	-	.021	-	-	-
135	-	-	-	.094	-	-	-	.014	-	-
136	-	-	.142	-	-	-	-	-	.008	-
137	-	.078	-	-	-	-	-	-	-	.001
138	.012	-	-	-	-	.036	-	-	-	-
139	-	-	-	-	.061	-	.022	-	-	-
140	-	-	-	.102	-	-	-	.015	-	-
141	-	-	.129	-	-	-	-	-	.008	-
142	-	.065	-	-	-	-	-	-	-	.002
143	.011	-	-	-	-	.042	-	-	-	-
144	-	-	-	-	.060	-	-	-	-	-
145	-	-	-	.107	-	-	-	.015	-	-
146	-	-	.139	-	-	-	-	-	.008	-

TABLE IX-5 (cont'd)

STATION NO.

Cycle No.	-35	0	50	80	130	170	200	225	250	300
147	-	.070	-	-	-	-	-	-	-	.003
148	.013	-	-	-	-	.041	-	-	-	-
149	-	-	-	-	.058	-	.023	-	-	-
150	-	-	-	.107	-	-	-	.019	-	-
151	-	-	.141	-	-	-	-	-	.012	-
152	-	.065	-	-	-	-	-	-	-	.007
153	.014	-	-	-	-	.044	-	-	-	-
154	-	-	-	-	.060	-	.024	-	-	-
155	-	-	-	.114	-	-	-	.016	-	-
156	-	-	.131	-	-	-	-	-	.011	-
157	-	.049	-	-	-	-	-	-	-	.005
158	.013	-	-	-	-	.042	-	-	-	-
159	-	-	-	-	.062	-	.025	-	-	-
160	-	-	-	.118	-	-	-	.014	-	-
161	-	-	.172	-	-	-	-	-	.010	-
162	-	.077	-	-	-	-	-	-	-	.002
163	.015	-	-	-	-	.043	-	-	-	-
164	-	-	-	-	.068	-	.023	-	-	-
165	-	-	-	.117	-	-	-	.015	-	-
166	-	-	.147	-	-	-	-	-	.008	-
167	-	.073	-	-	-	-	-	-	-	.004
168	.012	-	-	-	-	.044	-	-	-	-
169	-	-	-	-	.071	-	.025	-	-	-
170	-	-	-	.111	-	-	-	.014	-	-
171	-	-	.148	-	-	-	-	-	.011	-
172	-	.053	-	-	-	-	-	-	-	.004
173	.015	-	-	-	-	.046	-	-	-	-
174	-	-	-	-	.068	-	.024	-	-	-
175	-	-	-	.122	-	-	-	.015	-	-
176	-	-	.146	-	-	-	-	-	.016	-
177	-	.078	-	-	-	-	-	-	-	.003
180	.015	.073	.135	.117	.060	.043	.027	.020	.012	.004

TABLE IX-6

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 3 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3, 400 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

STATION NO.

Cycle No.	-35	0	50	80	130	170	200	225	250	300
0	-	-	-	.003						
1	-	-	-	.004						
2	-	-	.002	-	-					
3	-	-	-	.020	-					
4	-	.000	.008	-	-					
5	-	-	-	.026	.002					
6	-	.001	.008	-	-					
7	-	-	-	.039	.002					
8	-	.001	.018	-	-					

TABLE IX-6 (cont'd)

Cycle No.	STATION NO. -35	0	50	80	130	170	200	225	250	300
9	-	-	-	.043	.004					
10	-	.000	.020	-	-					
11	-	-	-	.042	.007	-				
12	-	-	.026	.049	-	-				
13	-	.001	-	-	.008	-				
14	-	-	.030	-	-	.001				
15	-	.001	-	.064	-	-				
16	-	-	.035	-	.013	-				
17	-	.001	-	-	-	.003				
18	.001	-	-	.067	-	-				
19	-	-	.035	-	.015	-				
20	-	.002	-	-	-	.007				
21	.000	-	-	.069	-	-				
22	-	-	.034	-	.021	-				
23	-	.001	-	-	-	.007				
24	.000	-	-	.073	-	-	-			
25	-	-	.038	-	.025	-	-	-		
26	-	.001	-	-	-	.010	-	-		
27	.000	-	-	-	-	-	.004	-		
28	-	-	.026	-	-	-	-	.003		
29	-	.002	-	.073	-	-	-	-		
30	.000	-	-	-	.028	-	-	-		
31	-	-	-	-	-	.013	-	-	-	
32	-	-	.050	-	-	-	.004	-	-	
33	-	.000	-	-	-	-	-	.004	-	
34	.000	-	-	-	-	-	-	-	.003	
35	-	-	-	.097	.038	-	-	-	-	
36	-	-	.054	-	-	.015	-	-	-	
37	-	.002	-	-	-	-	.007	-	-	
38	.000	-	-	-	-	-	-	.004	-	
39	-	-	-	.096	-	-	-	-	-	
40	-	-	.061	-	.047	-	-	-		
41	-	.003	-	-	-	.024	-	-	-	
42	.000	-	-	-	-	-	.008	-	-	
43	-	-	-	.088	-	-	-	.003	-	
44	-	-	.062	-	-	-	-	-	.002	
45	-	.003	-	-	.048	-	-	-	-	
46	.000	-	-	-	-	.026	-	-	-	
47	-	-	-	.091	-	-	.010	-	-	
48	-	-	.058	-	-	-	-	.008	-	
49	-	.003	-	-	-	-	-	-	.003	
50	.000	-	-	-	.048	-	-	-	-	
51	-	-	-	.105	-	.031	-	-	-	
52	-	-	.058	-	-	-	.011	-	-	
53	-	.004	-	-	-	-	-	.009	-	
54	.000	-	-	-	-	-	-	-	.003	
55	-	-	-	.126	.061	-	-	-	-	
56	-	-	.072	-	-	.032	-	-	-	
57	-	.002	-	-	-	-	.015	-	-	
58	.000	-	-	-	-	-	-	.012	-	
59	-	-	-	.118	-	-	-	-	.005	
60	-	-	.064	-	.067	-	-	-	-	
61	-	.005	-	-	-	.036	-	-	-	
62	.000	-	-	-	-	-	.015	-	-	
63	-	-	-	.127	-	-	-	.012	-	

TABLE IX-6 (cont'd)

Cycle No.	STATION NO.									
	-35	0	50	80	130	170	200	225	250	300
64	-	-	.072	-	-	-	-	-	.007	
65	-	.008	-	-	.065	-	-	-	-	
66	.000	-	-	-	-	.035	-	-	-	
67	-	-	-	.130	-	-	.016	-	-	
68	-	-	.083	-	-	-	-	.012	-	
69	-	.012	-	-	-	-	-	-	.008	
70	-	-	-	-	.073	-	-	-	-	
71	-	-	-	.123	-	.037	-	-	-	
72	-	-	.067	-	-	-	.018	-	-	
73	-	.012	-	-	-	-	-	.015	-	
74	.001	-	-	-	-	-	-	-	.008	
75	-	-	-	.103	.084	-	-	-	-	
76	-	-	.071	-	-	.043	-	-	-	
77	-	.013	-	-	-	-	.025	-	-	
78	.002	-	-	-	-	-	-	.019	-	
79	-	-	-	.097	-	-	-	-	.008	-
80	-	-	.104	-	-	-	-	-	-	-
81	-	.012	-	-	.085	-	-	-	-	-
82	.000	-	-	-	-	.037	-	-	-	.004
83	-	-	-	.162	-	-	.025	-	-	-
84	-	-	.094	-	-	-	-	.020	-	-
85	-	.010	-	-	-	-	-	-	.010	-
86	.000	-	-	-	.087	-	-	-	-	.003
87	-	-	-	.133	-	.042	-	-	-	-
88	-	-	.118	-	-	-	.025	-	-	-
89	-	.005	-	-	-	-	-	.018	-	-
90	.001	-	-	-	-	-	-	-	.012	-
91	-	-	-	.155	.087	-	-	-	-	.003
92	-	-	.083	-	-	.046	-	-	-	-
93	-	.008	-	-	-	-	.030	-	-	-
94	.000	-	-	-	-	-	-	.021	-	-
95	-	-	-	.110	-	-	-	-	.012	-
96	-	-	.110	-	.091	-	-	-	-	.004
97	-	.009	-	-	-	.049	-	-	-	-
98	.001	-	-	-	-	-	.030	-	-	-
99	-	-	-	.117	-	-	-	.023	-	-
100	-	-	.066	-	-	-	-	-	.009	-
101	-	.008	-	-	.090	-	-	-	-	.003
102	.000	-	-	-	-	.049	-	-	-	-
103	-	-	-	.135	-	-	.028	-	-	-
104	-	-	.194	-	-	-	-	.024	-	-
105	-	.008	-	-	-	-	-	-	.016	-
106	.000	-	-	-	.093	-	-	-	-	.005
107	-	-	-	.119	-	.053	-	-	-	-
108	-	-	.077	-	-	-	.036	-	-	-
109	-	.009	-	-	-	-	-	.027	-	-
110	.001	-	-	-	-	-	-	-	.015	-
111	-	-	-	.127	.093	-	-	-	-	.005
112	-	-	.097	-	-	.051	-	-	-	-
113	-	.010	-	-	-	-	.035	-	-	-
114	.002	-	-	-	-	-	-	.025	-	-
115	-	-	-	.123	-	-	-	-	.019	-
116	-	-	.091	-	.090	-	-	-	-	.005
117	-	.009	-	-	-	.058	-	-	-	-
118	.005	-	-	-	-	-	.039	-	-	-

TABLE IX-6 (cont'd)

Cycle No.	STATION NO. -35	0	50	80	130	170	200	225	250	300
119	-	-	-	.127	-	-	-	.031	-	-
120	-	-	.081	-	-	-	-	-	.016	-
121	-	.012	-	-	.099	-	-	-	-	.008
122	.000	-	-	-	-	.059	-	-	-	-
123	-	-	-	.115	-	-	.038	-	-	-
124	-	-	.093	-	-	-	-	.030	-	-
125	-	.008	-	-	-	-	-	-	.018	-
126	.000	-	-	-	.101	-	-	-	-	.005
127	-	-	-	.112	-	.061	-	-	-	-
128	-	-	.089	-	-	-	.041	-	-	-
129	-	.008	-	-	-	-	-	.031	-	-
130	.000	-	-	-	-	-	-	-	.020	-
131	-	-	-	.154	-	-	-	-	-	.010
132	-	-	.090	-	.096	.072	-	-	-	-
133	-	.007	-	-	-	-	-	-	-	-
134	.002	-	-	-	-	-	.042	-	-	-
135	-	-	-	.138	-	-	-	.033	-	-
136	-	-	.095	-	-	-	-	-	.021	-
137	-	.009	-	-	-	-	-	-	-	.010
138	.000	-	-	-	-	.073	-	-	-	-
139	-	-	-	-	.103	-	.043	-	-	-
140	-	-	-	.142	-	-	-	.031	-	-
141	-	-	.082	-	-	-	-	-	.023	-
142	-	.008	-	-	-	-	-	-	-	.008
143	.000	-	-	-	-	.069	-	-	-	-
144	-	-	-	-	.102	-	.044	-	-	-
145	-	-	-	.131	-	-	-	.037	-	-
146	-	-	.088	-	-	-	-	-	.022	-
147	-	.008	-	-	-	-	-	-	-	.009
148	.001	-	-	-	-	.077	-	-	-	-
149	-	-	-	-	.108	-	.046	-	-	-
150	-	-	-	.129	-	-	-	.039	-	-
151	-	-	.082	-	-	-	-	-	.024	-
152	-	.008	-	-	-	-	-	-	-	.009
153	-	-	-	-	-	.073	-	-	-	-
154	-	-	-	-	.110	-	.049	-	-	-
155	-	-	-	.143	-	-	-	.043	-	-
156	-	-	.090	-	-	-	-	-	.023	-
157	-	.009	-	-	-	-	-	-	-	.009
158	.000	-	-	-	-	.081	-	-	-	-
159	-	-	-	-	.096	-	.048	-	-	-
160	-	-	-	.146	-	-	-	.039	-	-
161	-	-	.094	-	-	-	-	-	.023	-
162	-	.012	-	-	-	-	-	-	-	.010
163	.001	-	-	-	-	.080	-	-	-	-
164	-	-	-	-	.112	-	.051	-	-	-
165	-	-	-	.127	-	-	-	.038	-	-
166	-	-	.089	-	-	-	-	-	.027	-
167	-	.011	-	-	-	-	-	-	-	.012
168	.000	-	-	-	-	.080	-	-	-	-
169	-	-	-	-	.115	-	.050	-	-	-
170	-	-	-	.152	-	-	-	.039	-	-
171	-	-	.096	-	-	-	-	-	.025	-
172	-	.010	-	-	-	-	-	-	-	.011
173	.001	-	-	-	-	.084	-	-	-	-
174	-	-	-	-	.118	-	.053	-	-	-

TABLE IX-6 (cont'd)

STATION NO.

Cycle No.	-35	0	50	80	130	170	200	225	250	300
175	-	-	-	.164	-	-	-	.043	-	-
176	-	-	.087	-	-	-	-	-	.031	-
177	-	.009	-	-	-	-	-	-	-	.016
180	.001	.011	.089	.142	.115	.070	.042	.037	.027	.008

TABLE IX-7

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 4 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station +130
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

STATION NO.

Cycle No.	0	50	80	130	170	200	225	250	300
1	-	-	-	.002	.001				
2	-	-	.001	-	.000				
3	-	-	-	.004	.000				
4	-	-	.004	-	.000				
5	-	.000	-	-	.001				
6	-	-	-	.012	-				
7	-	-	.008	-	.002	-			
8	-	.000	-	-	-	-			
9	-	-	-	.020	.002	-			
10	-	-	.013	-	-	.001			
11	-	.001	-	-	.007	-			
12	-	-	-	.019	-	.001	-		
13	-	-	.016	-	.004	-	-		
14	-	.000	-	-	-	.002	-		
15	-	-	-	.023	-	-	.000		
16	-	-	.019	-	.008	-	-		
17	-	.003	-	-	-	.002	-		
18	-	-	-	.028	-	-	.001		
19	-	-	.023	-	.009	-	-		
20	-	.003	-	-	-	.004	-		
21	-	-	-	.031	-	-	.002		
22	-	-	.026	-	.011	-	-		
23	-	.001	-	-	-	.005	-		
24	-	-	-	.037	-	-	.002		
25	-	-	.026	-	.014	-	-		
26	-	.004	-	-	-	.005	-		
27	-	-	-	.039	-	-	.003		
28	-	-	.027	-	.019	-	-		
29	-	.004	-	-	-	.008	-		
30	-	-	-	.047	-	-	.003		
31	-	-	.032	-	-	-	-		
32	-	.007	-	-	.020	-	-	-	
33	-	-	-	.045	-	.009	-	-	
34	-	-	.038	-	-	-	.003	-	
35	-	.007	-	-	-	-	-	.004	
36	-	-	-	.046	.022	-	-	-	
37	-	-	.033	-	-	.010	-	-	

TABLE IX-7 (cont'd)

Cycle No.	STATION NO.								
	0	50	80	130	170	200	225	250	300
38	-	.007	-	-	-	-	.005	-	
39	-	-	-	.047	-	-	-	.002	
40	-	-	.032	-	.026	-	-	-	
41	-	.008	-	-	-	.011	-	-	
42	-	-	-	.045	-	-	.005	-	
43	-	-	.036	-	-	-	-	.002	
44	-	.008	-	-	.027	-	-	-	
45	-	-	-	.054	-	.011	-	-	
46	-	-	.038	-	-	-	.007	-	
47	-	.010	-	-	-	-	-	.004	
48	-	-	-	.046	.025	-	-	-	
49	-	-	.035	-	-	.012	-	-	
50	-	.010	-	-	-	-	.007	-	
51	-	-	-	.057	-	-	-	.004	
52	-	-	.036	-	.032	-	-	-	
53	-	.009	-	-	-	.014	-	-	
54	-	-	-	.057	-	-	.008	-	
55	-	-	.045	-	-	-	-	.005	
56	-	.010	-	-	.031	-	-	-	
57	-	-	-	.064	-	.016	-	-	
58	-	-	.045	-	-	-	.010	-	
59	-	.012	-	-	-	-	-	.005	
60	-	-	-	.062	.038	-	-	-	
61	.001	-	.048	-	-	.018	-	-	
62	.001	.012	-	-	-	-	.009	-	
63	-	-	-	.062	-	-	-	.005	
64	-	-	.047	-	-	-	-	-	
65	-	.011	-	-	.037	-	-	-	
66	.002	-	-	-	-	.020	-	-	-
67	-	-	-	.069	-	-	.013	-	-
68	-	-	.047	-	-	-	-	.008	-
69	-	.012	-	-	-	-	-	-	.002
70	.003	-	-	-	.036	-	-	-	-
71	-	-	-	.066	-	.016	-	-	-
72	-	-	.046	-	-	-	.012	-	-
73	-	.011	-	-	-	-	-	.005	-
74	.002	-	-	-	-	-	-	-	.003
75	-	-	-	-	.038	-	-	-	-
76	-	-	-	.061	-	.020	-	-	-
77	-	-	.048	-	-	-	.012	-	-
78	-	.014	-	-	-	-	-	.009	-
79	.002	-	-	-	-	-	-	-	.001
80	-	-	-	-	.038	-	-	-	-
81	-	-	-	.072	-	.021	-	-	-
82	-	-	.047	-	-	-	.013	-	-
83	-	.015	-	-	-	-	-	.008	-
84	.003	-	-	-	-	-	-	-	.004
85	-	-	-	-	.043	-	-	-	-
86	-	-	-	.078	-	.021	-	-	-
87	-	-	.048	-	-	-	.014	-	-
88	-	.013	-	-	-	-	-	.009	-
89	.003	-	-	-	-	-	-	-	.002
90	-	-	-	-	.042	-	-	-	-
91	-	-	-	.076	-	.023	-	-	-
92	-	-	.054	-	-	-	.015	-	-

TABLE IX-7 (cont'd)

Cycle No.	STATION NO.								
	0	50	80	130	170	200	225	250	300
93	-	.020	-	-	-	-	-	.011	-
94	.003	-	-	-	-	-	-	-	.002
95	-	-	-	-	.041	-	-	-	-
96	-	-	-	.082	-	.024	-	-	-
97	-	-	.055	-	-	-	.015	-	-
98	-	.015	-	-	-	-	-	.009	-
99	.004	-	-	-	-	-	-	-	.001
100	-	-	-	-	.044	-	-	-	-
101	-	-	-	.074	-	.025	-	-	-
102	-	-	.057	-	-	-	.013	-	-
103	-	.018	-	-	-	-	-	.010	-
104	.003	-	-	-	-	-	-	-	.001
105	-	-	-	-	.043	-	-	-	-
106	-	-	-	.083	-	.026	-	-	-
107	-	-	.062	-	-	-	.018	-	-
108	-	.018	-	-	-	-	-	.010	-
109	.004	-	-	-	-	-	-	-	.003
110	-	-	-	-	.044	-	-	-	-
111	-	-	-	.072	-	.027	-	-	-
112	-	-	.061	-	-	-	.016	-	-
113	-	.022	-	-	-	-	-	.011	-
114	.004	-	-	-	-	-	-	-	.002
115	-	-	-	-	.046	-	-	-	-
116	-	-	-	.080	-	.026	-	-	-
117	-	-	.061	-	-	-	.016	-	-
118	-	.020	-	-	-	-	-	.010	-
119	.004	-	-	-	-	-	-	-	.002
120	-	-	-	-	.048	-	-	-	-
121	-	-	-	.080	-	.031	-	-	-
122	-	-	.059	-	-	-	.018	-	-
123	-	.022	-	-	-	-	-	.008	-
124	.005	-	-	-	-	-	-	-	.004
125	-	-	-	-	.050	-	-	-	-
126	-	-	-	.089	-	.031	-	-	-
127	-	-	.068	-	-	-	.019	-	-
128	-	.019	-	-	-	-	-	.015	-
129	.004	-	-	-	-	-	-	-	.004
130	-	-	-	-	.050	-	-	-	-
131	-	-	-	.077	-	.031	-	-	-
132	-	-	.064	-	-	-	.020	-	-
133	-	.023	-	-	-	-	-	.013	-
134	.004	-	-	-	-	-	-	-	.005
135	-	-	-	-	.055	-	-	-	-
136	-	-	-	.084	-	.027	-	-	-
137	-	-	.043	-	-	-	.012	-	-
138	-	.023	-	-	-	-	-	.013	-

TABLE IX-8

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 4 L.W.S. CONCENTRATION READINGS EXPRESSED AS PER CENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station +130
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO.								
	0	50	80	130	170	200	225	250	300
1	-	-	-	.004	.004	-			
2	-	-	.000	-	.007	-			
3	-	-	-	.008	.014	.002			
4	-	-	.000	-	.014	-			
5	-	.000	-	-	.016	-			
6	-	-	-	.014	-	.004			
7	-	-	.000	-	.023	-			
8	-	.000	-	-	-	.004			
9	-	-	-	.018	.025	-			
10	-	-	.000	-	-	.008	-		
11	-	.000	-	-	.024	-	-		
12	-	-	-	.023	-	.008	-		
13	-	-	.001	-	.032	-	.004		
14	-	.000	-	-	-	.011	-		
15	-	-	-	.025	-	-	.005		
16	-	-	.000	-	.038	-	-		
17	-	.001	-	-	-	.011	-		
18	-	-	-	.031	-	-	.007		
19	-	-	.002	-	.034	-	-	-	
20	-	.000	-	-	-	.014	-	-	
21	-	-	-	.031	-	-	.010	-	
22	-	-	.003	-	.042	-	-	.002	
23	-	.000	-	-	-	.019	-	-	
24	-	-	-	.035	-	-	.012	-	
25	-	-	.003	-	.047	-	-	-	
26	-	.000	-	-	-	.021	-	-	
27	-	-	-	.041	-	-	.012	.004	
28	-	-	.004	-	.044	-	-	-	
29	-	.000	-	-	-	.019	-	-	
30	-	-	-	.047	-	-	.013	-	
31	-	-	.004	-	-	-	-	.005	
32	-	.000	-	-	.050	-	-	-	
33	-	-	-	.043	-	.026	-	-	
34	-	-	.008	-	-	-	.018	-	
35	-	.000	-	-	-	-	-	.008	
36	-	-	-	.043	.060	-	-	-	
37	-	-	.004	-	-	.027	-	-	
38	-	.000	-	-	-	-	.020	-	
39	-	-	-	.046	-	-	-	.009	
40	-	-	.007	-	.057	-	-	-	
41	-	.001	-	-	-	.030	-	-	
42	-	-	-	.050	-	-	.022	-	
43	-	-	.007	-	-	-	-	.009	
44	-	.000	-	-	.066	-	-	-	-
45	-	-	-	.055	-	.034	-	-	-
46	-	-	.008	-	-	-	.019	-	-
47	-	.000	-	-	-	-	-	.012	.004
48	-	-	-	.051	.061	-	-	-	-

TABLE IX-8 (cont'd)

Cycle No.	STATION NO. 0	50	80	130	170	200	225	250	300
49	-	-	.008	-	-	.033	-	-	-
50	-	.001	-	-	-	-	.025	-	-
51	-	-	-	.054	-	-	-	.013	-
52	-	-	.008	-	.066	-	-	-	-
53	-	.000	-	-	-	.035	-	-	-
54	-	-	-	.056	-	-	.027	-	-
55	-	-	.011	-	-	-	-	.016	.004
56	-	.002	-	-	.070	-	-	-	-
57	-	-	-	.058	-	.038	-	-	-
58	-	-	.012	-	-	-	.028	-	-
59	-	.002	-	-	-	-	-	.018	.005
60	-	-	-	.061	.074	-	-	-	-
61	-	-	.009	-	-	.038	-	-	-
62	.002	.002	-	-	-	-	.028	-	-
63	-	-	-	.057	-	-	-	.018	-
64	-	-	.010	-	-	-	-	-	.008
65	-	.004	-	-	.076	-	-	-	-
66	.000	-	-	-	-	.043	-	-	-
67	-	-	-	.059	-	-	.034	-	-
68	-	-	.011	-	-	-	-	.020	-
69	-	.000	-	-	-	-	-	-	.005
70	.000	-	-	-	.069	-	-	-	-
71	-	-	-	.051	-	.038	-	-	-
72	-	-	.009	-	-	-	.036	-	-
73	-	.002	-	-	-	-	-	.019	-
74	.000	-	-	-	-	-	-	-	.009
75	-	-	-	-	.069	-	-	-	-
76	-	-	-	.060	-	.046	-	-	-
77	-	-	.013	-	-	-	.034	-	-
78	-	.001	-	-	-	-	-	.021	-
79	.000	-	-	-	-	-	-	-	.008
80	-	-	-	-	.080	-	-	-	-
81	-	-	-	.066	-	.047	-	-	-
82	-	-	.014	-	-	-	.037	-	-
83	-	.003	-	-	-	-	-	.022	-
84	.000	-	-	-	-	-	-	-	.011
85	-	-	-	-	.079	-	-	-	-
86	-	-	-	.068	-	.048	-	-	-
87	-	-	.015	-	-	-	.038	-	-
88	-	.004	-	-	-	-	-	.023	-
89	.000	-	-	-	-	-	-	-	.009
90	-	-	-	-	.077	-	-	-	-
91	-	-	-	.066	-	.050	-	-	-
92	-	-	.015	-	-	-	.042	-	-
93	-	.003	-	-	-	-	-	.021	-
94	.001	-	-	-	-	-	-	-	.008
95	-	-	-	-	.077	-	-	-	-
96	-	-	-	.069	-	.051	-	-	-
97	-	-	.016	-	-	-	.038	-	-
98	-	.003	-	-	-	-	-	.023	-
99	.001	-	-	-	-	-	-	-	.008
100	-	-	-	-	.084	-	-	-	-
101	-	-	-	.061	-	.054	-	-	-
102	-	-	.016	-	-	-	.041	-	-
103	-	.002	-	-	-	-	-	.022	-

TABLE IX-8 (cont'd)

Cycle No.	STATION NO. 0	50	80	130	170	200	225	250	300
104	.000	-	-	-	-	-	-	-	.009
105	-	-	-	-	.085	-	-	-	-
106	-	-	-	.066	-	.055	-	-	-
107	-	-	.018	-	-	-	.043	-	-
108	-	.003	-	-	-	-	-	.023	-
109	.001	-	-	-	-	-	-	-	.010
110	-	-	-	-	.080	-	-	-	-
111	-	-	-	.067	-	.055	-	-	-
112	-	-	.020	-	-	-	.043	-	-
113	-	.002	-	-	-	-	-	.024	-
114	.002	-	-	-	-	-	-	-	.010
115	-	-	-	-	.081	-	-	-	-
116	-	-	-	.069	-	.055	-	-	-
117	-	-	.019	-	-	-	.041	-	-
118	-	.005	-	-	-	-	-	.026	-
119	.001	-	-	-	-	-	-	-	.011
120	-	-	-	-	.090	-	-	-	-
121	-	-	-	.072	-	.060	-	-	-
122	-	-	.020	-	-	-	.038	-	-
123	-	.004	-	-	-	-	-	.024	-
124	.002	-	-	-	-	-	-	-	.011
125	-	-	-	-	.088	-	-	-	-
126	-	-	-	.078	-	.056	-	-	-
127	-	-	.024	-	-	-	.046	-	-
128	-	.005	-	-	-	-	-	.030	-
129	.000	-	-	-	-	-	-	-	.012
130	-	-	-	-	.082	-	-	-	-
131	-	-	-	.068	-	.059	-	-	-
132	-	-	.018	-	-	-	-	-	-
133	-	.007	-	-	-	-	-	.030	-
134	.000	-	-	-	-	-	-	-	.013
135	-	-	-	-	.095	-	-	-	-
136	-	-	-	.078	-	.038	-	-	-
137	-	-	.014	-	-	-	.047	-	-
138	-	.008	-	-	-	-	-	.031	-

TABLE IX-9

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 5 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station +170
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
1	-	-	.003	-	.001	-		
2	-	-	-	.004	-	.002		
3	-	-	.007	-	-	-	-	
4	-	-	-	.008	.001	-	-	-
5	-	-	.011	-	-	.001	-	-
6	-	-	-	.014	-	-	.000	-

TABLE IX-9 (cont'd)

Cycle No.	STATION NO.							
	50	80	130	170	200	225	250	300
7	-	-	.015	-	-	-	-	.000
8	-	-	-	-	.003	-	-	-
9	-	-	-	.020	-	.000	-	-
10	-	-	.019	-	-	-	.001	-
11	-	.000	-	-	-	-	-	.001
12	-	-	-	.023	.004	-	-	-
13	-	-	.023	-	-	.002	-	-
14	-	.001	-	-	-	-	.000	-
15	-	-	-	.025	-	-	-	.000
16	-	-	.026	-	-	-	-	-
17	-	.000	-	-	.009	-	-	-
18	-	-	-	-	-	.004	-	-
19	-	-	-	.027	-	-	.001	-
20	-	-	.028	-	-	-	-	.000
21	-	.003	-	-	-	-	-	-
22	-	-	-	-	.008	-	-	-
23	-	-	-	.031	-	.005	-	-
24	-	-	.036	-	-	-	.004	-
25	-	.003	-	-	-	-	-	.001
27	-	-	-	.039	.014	-	-	-
28	-	-	.042	-	-	.005	-	-
29	-	.002	-	-	-	-	.002	-
30	.000	-	-	-	-	-	-	.000
32	-	-	-	.037	.014	-	-	-
33	-	-	.036	-	-	.008	-	-
34	-	.007	-	-	-	-	.004	-
35	.001	-	-	-	-	-	-	.000
37	-	-	-	.046	.015	-	-	-
38	-	-	.045	-	-	.008	-	-
39	-	-	-	-	-	-	.006	-
40	.001	-	-	-	-	-	-	.002
42	-	-	-	.045	.020	-	-	-
43	-	-	.042	-	-	.010	-	-
44	-	.009	-	-	-	-	.006	-
45	.001	-	-	-	-	-	-	.000
47	-	-	-	.046	.020	-	-	-
48	-	-	.044	-	-	.013	-	-
49	-	.011	-	-	-	-	.007	-
50	.001	-	-	-	-	-	-	.004
52	-	-	-	.050	.023	-	-	-
53	-	-	.050	-	-	.013	-	-
54	-	.012	-	-	-	-	.010	-
55	.002	-	-	-	-	-	-	-
57	-	-	-	.051	.001	-	-	-
58	-	-	.047	-	-	.015	-	-
59	-	.010	-	-	-	-	.012	-
60	.001	-	-	-	-	-	-	.002
62	-	-	-	.051	.001	-	-	-
63	-	-	.054	-	-	.016	-	-
64	-	.010	-	-	-	-	.009	-
65	.002	-	-	-	-	-	-	.001
67	-	-	-	.061	.027	-	-	-
68	-	-	.057	-	-	.015	-	-
69	-	.013	-	-	-	-	.010	-
70	.002	-	-	-	-	-	-	.001

TABLE IX-9 (cont'd)

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
72	-	-	-	.061	.031	-	-	-
73	-	-	.061	-	-	.018	-	-
74	-	.016	-	-	-	-	.012	-
75	.004	-	-	-	-	-	-	.002
77	-	-	-	.062	.031	-	-	-
78	-	-	.057	-	-	.019	-	-
79	-	.015	-	-	-	-	.013	-
80	.004	-	-	-	-	-	-	.004
82	-	-	-	.064	.030	-	-	-
83	-	-	.064	-	-	.018	-	-
84	-	.016	-	-	-	-	.013	-
85	.004	-	-	-	-	-	-	.003
87	-	-	-	.062	.031	-	-	-
88	-	-	.065	-	-	.018	-	-
89	-	.016	-	-	-	-	.015	-
90	.004	-	-	-	-	-	-	.002
92	-	-	-	.068	.032	-	-	-
93	-	-	.064	-	-	.022	-	-
94	-	.019	-	-	-	-	.013	-
95	.004	-	-	-	-	-	-	.004
97	-	-	-	.066	.035	-	-	-
98	-	-	.069	-	-	.023	-	-
99	-	.018	-	-	-	-	.015	-
100	.004	-	-	-	-	-	-	.003
102	-	-	-	.065	.035	-	-	-
103	-	-	.061	-	-	.023	-	-
104	-	.020	-	-	-	-	.015	-
105	.004	-	-	-	-	-	-	.001
107	-	-	-	.069	.034	-	-	-
108	-	-	.066	-	-	.021	-	-
109	-	.018	-	-	-	-	.015	-
110	.006	-	-	-	-	-	-	.003
112	-	-	-	.066	.037	-	-	-
113	-	-	.065	-	-	.023	-	-
114	-	.019	-	-	-	-	.018	-
115	.004	-	-	-	-	-	-	.004
117	-	-	-	.070	.037	-	-	-
118	-	-	.072	-	-	.024	-	-
119	-	.019	-	-	-	-	.015	-
120	.004	-	-	-	-	-	-	.004
122	-	-	-	.069	.037	-	-	-
123	-	-	.069	-	-	.026	-	-
124	-	.020	-	-	-	-	.019	-
125	.008	-	-	-	-	-	-	.003
127	-	-	-	.074	.038	-	-	-
128	-	-	.060	-	-	.025	-	-
129	-	.019	-	-	-	-	.015	-
130	.005	-	-	-	-	-	-	.004
132	-	-	-	.072	.038	-	-	-
133	-	-	.070	-	-	.022	-	-
134	-	.021	-	-	-	-	.018	-
135	.005	-	-	-	-	-	-	.003
137	-	-	-	.069	.042	-	-	-
138	-	-	.068	-	-	.026	-	-
139	-	.021	-	-	-	-	.018	-

TABLE IX-9 (cont'd)

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
140	.007	-	-	-	-	-	-	.004
142	-	-	-	.074	.041	-	-	-
143	-	-	.076	-	-	.072	-	-
144	-	.024	-	-	-	-	.015	-
145	.007	-	-	-	-	-	-	.007
147	-	-	-	.069	.041	-	-	-
148	-	-	.064	-	-	.026	-	-
149	-	.020	-	-	-	-	.018	-
150	.004	-	-	-	-	-	-	.004
152	-	-	-	.069	.044	-	-	-
153	-	-	.071	-	-	.026	-	-
154	-	.024	-	-	-	-	.020	-
155	.007	-	-	-	-	-	-	.007
157	-	-	-	.071	.042	-	-	-
158	-	-	.073	-	-	.030	-	-
159	-	.024	-	-	-	-	.015	-
160	.008	-	-	-	-	-	-	.004
162	-	-	-	.072	.045	-	-	-
163	-	-	.070	-	-	.031	-	-
164	-	.024	-	-	-	-	.020	-
165	.007	-	-	-	-	-	-	.007
167	-	-	-	.066	.044	-	-	-
168	-	-	.069	-	-	.027	-	-
169	-	.024	-	-	-	-	.019	-
170	.009	-	-	-	-	-	-	.004
172	-	-	-	.068	.044	-	-	-
173	-	-	.073	-	-	.028	-	-
174	-	.023	-	-	-	-	.019	-
175	.008	-	-	-	-	-	-	.008
177	-	-	-	.077	.046	-	-	-
180	.007	.026	.076	.077	.035	.025	.019	.016

TABLE IX-10

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 5 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station +170
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
1	-	-	-	-	.004	.002	-	-
2	-	-	-	.002	-	.001	.001	-
4	-	-	-	.004	.008	-	-	-
5	-	-	-	-	-	.005	-	.000
6	-	-	-	.012	-	-	.002	-
7	-	-	.000	-	-	-	-	.000
8	-	-	-	-	.019	-	-	-
9	-	-	-	.014	-	.012	-	-
10	-	-	.000	-	-	-	.005	-
11	-	-	-	-	-	-	-	.002

TABLE IX-10 (cont'd)

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
12	-	-	-	.014	.019	-	-	-
13	-	-	.001	-	-	.012	-	-
14	-	-	-	-	-	-	.007	-
15	-	-	-	.021	-	-	-	.002
16	-	-	.004	-	-	-	-	-
17	-	-	-	-	.031	-	-	-
18	-	-	-	-	-	.020	-	-
19	-	-	-	.023	-	-	.009	-
20	-	-	.004	-	-	-	-	.003
22	-	-	-	-	.032	-	-	-
23	-	-	-	.026	-	.023	-	-
24	-	-	.008	-	-	-	.011	-
25	-	-	-	-	-	-	-	.003
27	-	-	-	.031	.042	-	-	-
28	-	-	.009	-	-	.026	-	-
29	-	-	-	-	-	-	.015	-
30	-	-	-	-	-	-	-	.002
32	-	-	-	.033	.043	-	-	-
33	-	-	.010	-	-	.028	-	-
34	-	.000	-	-	-	-	.016	-
35	-	-	-	-	-	-	-	.004
37	-	-	-	.038	.041	-	-	-
38	-	-	.010	-	-	.034	-	-
39	-	.000	-	-	-	-	.016	-
40	.000	-	-	-	-	-	-	.007
42	-	-	-	.030	.046	-	-	-
43	-	-	.015	-	-	034	-	-
44	-	.002	-	-	-	-	.020	-
45	.000	-	-	-	-	-	-	.005
47	-	-	-	.043	.049	-	-	-
48	-	-	.012	-	-	.036	-	-
49	-	.001	-	-	-	-	.020	-
50	.001	-	-	-	-	-	-	.005
52	-	-	-	.046	.053	-	-	-
53	-	-	.016	-	-	.041	-	-
54	-	.002	-	-	-	-	.025	-
55	.000	-	-	-	-	-	-	.004
57	-	-	-	.047	.053	-	-	-
58	-	-	.016	-	-	.042	-	-
59	-	.001	-	-	-	-	.027	-
60	.000	-	-	-	-	-	-	.008
62	-	-	-	.046	.055	-	-	-
63	-	-	.016	-	-	.043	-	-
64	-	.002	-	-	-	-	.024	-
65	.001	-	-	-	-	-	-	.005
67	-	-	-	.054	.057	-	-	-
68	-	-	.021	-	-	.043	-	-
69	-	.003	-	-	-	-	.022	-
70	.000	-	-	-	-	-	-	.007
72	-	-	-	.054	.060	-	-	-
73	-	-	.022	-	-	.044	-	-
74	-	.003	-	-	-	-	.025	-
75	.001	-	-	-	-	-	-	.012
77	-	-	-	.055	.058	-	-	-
78	-	-	.020	-	-	.048	-	-

TABLE IX-10 (cont'd)

Cycle No.	STATION NO. 50	80	130	170	200	225	250	300
79	-	.004	-	-	-	-	.030	-
80	.000	-	-	-	-	-	-	.012
82	-	-	-	.058	.061	-	-	-
83	-	-	.025	-	-	.046	-	-
84	-	.004	-	-	-	-	.027	-
85	.002	-	-	-	-	-	-	.009
87	-	-	-	.056	.058	-	-	-
88	-	-	.025	-	-	.045	-	-
89	-	.004	-	-	-	-	.034	-
90	.001	-	-	-	-	-	-	.013
92	-	-	-	.059	.065	-	-	-
93	-	-	.025	-	-	.054	-	-
94	-	.004	-	-	-	-	.033	-
95	.001	-	-	-	-	-	-	.014
97	-	-	-	.058	.066	-	-	-
98	-	-	.023	-	-	.049	-	-
99	-	.008	-	-	-	-	.034	-
100	.000	-	-	-	-	-	-	.012
102	-	-	-	.060	.065	-	-	-
103	-	-	.024	-	-	.050	-	-
104	-	.003	-	-	-	-	.035	-
105	.003	-	-	-	-	-	-	.012
107	-	-	-	.060	.066	-	-	-
108	-	-	.023	-	-	.046	-	-
109	-	.005	-	-	-	-	.034	-
110	.004	-	-	-	-	-	-	.014
112	-	-	-	.060	.070	-	-	-
113	-	-	.023	-	-	.051	-	-
114	-	.005	-	-	-	-	.038	-
115	.002	-	-	-	-	-	-	.016
117	-	-	-	.059	.067	-	-	-
118	-	-	.028	-	-	.056	-	-
119	-	.004	-	-	-	-	.035	-
120	.001	-	-	-	-	-	-	.016
122	-	-	-	.061	.068	-	-	-
123	-	-	.028	-	-	.056	-	-
124	-	.005	-	-	-	-	.033	-
125	.001	-	-	-	-	-	-	.015
127	-	-	-	.068	.073	-	-	-
128	-	-	.028	-	-	.058	-	-
129	-	.005	-	-	-	-	.035	-
130	.002	-	-	-	-	-	-	.014
132	-	-	-	.058	.065	-	-	-
133	-	-	.026	-	-	.058	-	-
134	-	.005	-	-	-	-	.038	-
135	.002	-	-	-	-	-	-	.014
137	-	-	-	.061	.070	-	-	-
138	-	-	.028	-	-	-	-	-
139	-	.005	-	-	-	-	.035	-
140	.001	-	-	-	-	-	-	.018
142	-	-	-	.064	.070	-	-	-
143	-	-	.024	-	-	.054	-	-
144	-	.008	-	-	-	-	.035	-
145	.002	-	-	-	-	-	-	.018

TABLE IX-10 (cont'd)

STATION NO.

Cycle No.	50	80	130	170	200	225	250	300
147	-	-	-	.062	.071	-	-	-
148	-	-	.026	-	-	.058	-	-
149	-	.007	-	-	-	-	.043	-
150	.002	-	-	-	-	-	-	.018
152	-	-	-	.067	.077	-	-	-
153	-	-	.028	-	-	.061	-	-
154	-	.008	-	-	-	-	.039	-
155	.001	-	-	-	-	-	-	.000
157	-	-	-	.066	.073	-	-	-
158	-	-	.031	-	-	.060	-	-
159	-	.005	-	-	-	-	.044	-
160	.002	-	-	-	-	-	-	.018
162	-	-	-	.061	.077	-	-	-
163	-	-	.034	-	-	.062	-	-
164	-	.008	-	-	-	-	.041	-
165	.001	-	-	-	-	-	-	.019
167	-	-	-	.069	.077	-	-	-
168	-	-	.031	-	-	.061	-	-
169	-	.007	-	-	-	-	.039	-
170	.001	-	-	-	-	-	-	.015
172	-	-	-	.069	.074	-	-	-
173	-	-	.028	-	-	.061	-	-
174	-	.005	-	-	-	-	.043	-
175	.002	-	-	-	-	-	-	.014
177	-	-	-	.068	.076	-	-	-
180	.003	.007	.031	.080	.065	.060	.041	.006

TABLE IX-11

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 6 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 5,500 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

STATION NO.

Cycle No.	-20	0	25	50	80	100	130	170	200	225	250	275	300
0	-	-	.004	-	-								
2	-	-	.007	.009	-								
3	-	-	-	.012	.000								
4	-	-	.016	-	-	-							
5	-	-	-	.022	-	-	-						
6	-	-	.023	-	.001	-	-						
7	-	.004	-	-	-	.000	-						
8	-	-	-	.031	-	-	.000						

TABLE IX-11 (cont'd)

Cycle No.	STATION NO.												
	-20	0	25	50	80	100	130	170	200	225	250	275	300
9	-	-	.034	-	.005	-	-						
10	-	.007	-	-	-	.002	-						
11	-	-	-	.039	-	-	.002						
12	-	-	.037	-	.014	-	-						
13	-	.007	-	-	-	.003	-						
14	-	-	-	.046	-	-	.000						
15	-	-	.039	-	.015	-	-						
16	-	.013	-	-	-	.012	-						
17	-	-	-	.054	-	-	.001						
18	-	-	.043	-	.028	-	-						
19	-	.015	-	-	-	.013	-						
20	.002	-	-	-	-	-	.005						
21	-	-	-	.057	.033	-	-						
22	-	-	.054	-	-	.019	-						
23	-	.015	-	-	-	-	.004						
24	.004	-	-	-	.034	-	-						
25	-	-	-	.070	-	.026	-						
26	-	-	.050	-	-	-	.008						
27	-	.014	-	-	.042	-	-	-	-				
28	.004	-	-	-	-	.036	-	-	-				
29	-	-	-	.072	-	-	.013	-	-				
30	-	-	.061	-	-	-	-	.004	.000				
31	-	.018	-	-	-	-	-	.004	-				
32	.005	-	-	-	.046	-	-	-	-				
33	-	-	-	.081	-	.033	-	-	-	-			
34	-	-	.054	-	-	-	.016	-	-	-			
35	-	.019	-	-	-	-	-	.009	-	-			
36	.004	-	-	-	-	-	-	-	.003	.002			
37	-	-	-	-	.056	.046	-	-	-	-			
38	-	-	-	.081	-	-	.019	-	-	-			
39	-	-	.059	-	-	-	-	.008	-	-			
40	-	.020	-	-	-	-	-	-	.003	-			
41	.007	-	-	-	-	-	-	-	-	.003			
42	-	-	-	-	.056	-	-	-	-	-			
43	-	-	-	.083	-	.047	-	-	-	-			
44	-	-	.066	-	-	-	.020	-	-	-			
45	-	.023	-	-	-	-	-	.010	-	-			
46	.004	-	-	-	-	-	-	-	.004	-			
47	-	-	-	-	.060	-	-	-	-	-			
48	-	-	-	.084	-	-	-	-	-	-			
49	-	-	.061	-	-	-	-	-	-	-			
50	-	.024	-	-	-	.042	-	-	-	-			
51	.005	-	-	-	-	-	.028	-	-	-			
52	-	-	-	-	.067	-	-	.012	-	-	-		
53	-	-	-	.083	-	-	-	-	.004	-	-		
54	-	-	.059	-	-	-	-	-	-	.003	-		
55	-	.022	-	-	-	-	-	-	-	-	.001		
56	.007	-	-	-	-	-	-	-	-	-	-		
57	-	-	-	-	.042	.055	-	-	-	-	-		
58	-	-	-	.078	-	-	.041	-	-	-	-		
59	-	-	.062	-	-	-	-	.019	-	-	-		
60	-	.024	-	-	-	-	-	-	.009	-	-	-	
61	.008	-	-	-	-	-	-	-	-	.005	-	-	
62	-	-	-	-	.056	-	-	-	-	-	.003	-	
63	-	-	-	.077	-	-	-	-	-	-	-	.002	

TABLE IX-11 (cont'd)

Cycle No.	STATION NO.												
	-20	0	25	50	80	100	130	170	200	225	250	275	300
64	-	-	.065	-	-	-	-	-	-	-	-	-	
65	-	.025	-	-	-	-	-	-	-	-	-	-	
66	.008	-	-	-	-	-	.041	-	-	-	-	-	
67	-	-	-	-	.060	-	-	.020	-	-	-	-	
68	-	-	-	.085	-	-	-	-	.010	-	-	-	
69	-	-	.061	-	-	-	-	-	-	.008	-	-	-
70	-	.023	-	-	-	-	-	-	-	-	.004	-	-
71	.007	-	-	-	-	-	-	-	-	-	-	.000	-
72	-	-	-	-	-	.065	-	-	-	-	-	-	.001
73	-	-	-	-	.067	-	.041	-	-	-	-	-	-
74	-	-	-	.094	-	-	-	.025	-	-	-	-	-
75	-	-	.058	-	-	-	-	-	.014	-	-	-	-
76	-	.023	-	-	-	-	-	-	-	.008	-	-	-
77	.005	-	-	-	-	-	-	-	-	-	.004	-	-
78	-	-	-	-	-	.059	-	-	-	-	-	.002	-
79	-	-	-	-	.077	-	-	-	-	-	-	-	.001
80	-	-	-	.066	-	-	.042	-	-	-	-	-	-
81	-	-	.069	-	-	-	-	.030	-	-	-	-	-
82	-	.020	-	-	-	-	-	-	.014	-	-	-	-
83	.007	-	-	-	-	-	-	-	-	.009	-	-	-
84	-	-	-	-	-	.067	-	-	-	-	.007	-	-
85	-	-	-	-	.074	-	-	-	-	-	-	.002	-
86	-	-	-	.085	-	-	-	-	-	-	-	-	.000
87	-	-	.057	-	-	-	.050	-	-	-	-	-	-
88	-	.019	-	-	-	-	-	.031	-	-	-	-	-
89	.008	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	.072	-	-	-	.011	-	-	-
91	-	-	-	-	.079	-	-	-	-	-	.007	-	-
92	-	-	-	.089	-	-	-	-	-	-	-	.003	-
93	-	-	.066	-	-	-	-	-	-	-	-	-	.001
94	-	.020	-	-	-	-	.057	-	-	-	-	-	-
95	.008	-	-	-	-	-	-	.033	-	-	-	-	-
96	-	-	-	-	-	.080	-	-	.019	-	-	-	-
97	-	-	-	-	.073	-	-	-	-	.013	-	-	-
98	-	-	-	.084	-	-	-	-	-	-	.009	-	-
99	-	-	.072	-	-	-	-	-	-	-	-	.004	-
100	-	.025	-	-	-	-	-	-	-	-	-	-	.003
101	.009	-	-	-	-	-	.061	-	-	-	-	-	-
102	-	-	-	-	-	.062	-	.036	-	-	-	-	-
103	-	-	-	-	.067	-	-	-	.020	-	-	-	-
104	-	-	-	.093	-	-	-	-	-	.012	-	-	-
105	-	-	.062	-	-	-	-	-	-	-	.009	-	-
106	-	.027	-	-	-	-	-	-	-	-	-	.004	-
107	.009	-	-	-	-	-	-	-	-	-	-	-	.003
108	-	-	-	-	-	.073	.049	-	-	-	-	-	-
109	-	-	-	-	.072	-	-	.035	-	-	-	-	-
110	-	-	-	.082	-	-	-	-	.022	-	-	-	-
111	-	-	.068	-	-	-	-	-	-	.014	-	-	-
112	-	.027	-	-	-	-	-	-	-	-	.008	-	-
113	.008	-	-	-	-	-	-	-	-	-	-	.008	-
114	-	-	-	-	-	.070	-	-	-	-	-	-	.003
115	-	-	-	-	.081	-	.057	-	-	-	-	-	-
116	-	-	-	.090	-	-	-	.037	-	-	-	-	-
117	-	-	.070	-	-	-	-	-	.023	-	-	-	-
118	-	.027	-	-	-	-	-	-	-	.015	-	-	-

TABLE IX-11 (cont'd)

Cycle	STATION NO.												
No.	-20	0	25	50	80	100	130	170	200	225	250	275	300
119	.010	-	-	-	-	-	-	-	-	-	.009	-	-
120	-	-	-	-	-	.080	-	-	-	-	-	.007	-
121	-	-	-	-	.084	-	-	-	-	-	-	-	.003
122	-	-	-	.079	-	-	.061	-	-	-	-	-	-
123	-	-	.069	-	-	-	-	.043	-	-	-	-	-
124	-	.027	-	-	-	-	-	-	.025	-	-	-	-
125	.010	-	-	-	-	-	-	-	-	.016	-	-	-
126	-	-	-	-	-	.077	-	-	-	-	.012	-	-
127	-	-	-	-	.084	-	-	-	-	-	-	.008	-
128	-	-	-	.106	-	-	-	-	-	-	-	-	.004
129	-	-	.065	-	-	-	.061	-	-	-	-	-	-
130	-	.025	-	-	-	-	-	.045	-	-	-	-	-
131	.008	-	-	-	-	-	-	-	.024	-	-	-	-
132	-	-	-	-	-	.071	-	-	-	.018	-	-	-
133	-	-	-	-	.082	-	-	-	-	-	.012	-	-
134	-	-	-	.094	-	-	-	-	-	-	-	.008	-
135	-	-	.069	-	-	-	-	-	-	-	-	-	.004
136	-	.021	-	-	-	-	.061	-	-	-	-	-	-
137	.005	-	-	-	-	-	-	.042	-	-	-	-	-
138	-	-	-	-	-	.073	-	-	.023	-	-	-	-
139	-	-	-	-	.083	-	-	-	-	.015	-	-	-
140	-	-	-	.087	-	-	-	-	-	-	.015	-	-
141	-	-	.074	-	-	-	-	-	-	-	-	.009	-
142	-	.022	-	-	-	-	-	-	-	-	-	-	.004
143	.005	-	-	-	-	-	.044	-	-	-	-	-	-
144	-	-	-	-	-	.079	-	.031	-	-	-	-	-
145	-	-	-	-	.082	-	-	-	.023	-	-	-	-
146	-	-	-	.089	-	-	-	-	-	.020	-	-	-
147	-	-	.074	-	-	-	-	-	-	-	.013	-	-
148	-	.028	-	-	-	-	-	-	-	-	-	.007	-
149	.005	-	-	-	-	-	-	-	-	-	-	-	.004
150	-	-	-	-	-	.073	.057	-	-	-	-	-	-
151	-	-	-	-	.056	-	-	.039	-	-	-	-	-
152	-	-	-	.074	-	-	-	-	.027	-	-	-	-
153	-	-	.066	-	-	-	-	-	-	.019	-	-	-
154	-	.025	-	-	-	-	-	-	-	-	.014	-	-
155	.007	-	-	-	-	-	-	-	-	-	-	.009	-
156	-	-	-	-	-	.077	-	-	-	-	-	-	.004
157	-	-	-	-	.084	-	.062	-	-	-	-	-	-
158	-	-	-	.097	-	-	-	.043	-	-	-	-	-
159	-	-	.062	-	-	-	-	-	.027	-	-	-	-
160	-	.023	-	-	-	-	-	-	-	.023	-	-	-
161	.008	-	-	-	-	-	-	-	-	-	.014	-	-
162	-	-	-	-	-	.078	-	-	-	-	-	.009	-
163	-	-	-	-	.085	-	-	-	-	-	-	-	.004
164	-	-	-	.083	-	-	.061	-	-	-	-	-	-
165	-	-	.060	-	-	-	-	.043	-	-	-	-	-
166	-	.023	-	-	-	-	-	-	.031	-	-	-	-
167	.007	-	-	-	-	-	-	-	-	.023	-	-	-
168	-	-	-	-	-	.074	-	-	-	-	.012	-	-
169	-	-	-	-	.083	-	-	-	-	-	-	.010	-
170	-	-	-	.092	-	-	-	-	-	-	-	-	.004
171	-	-	.061	-	-	-	.066	-	-	-	-	-	-
172	-	.021	-	-	-	-	-	.047	-	-	-	-	-
173	.008	-	-	-	-	-	-	-	.031	-	-	-	-

TABLE IX-11 (cont'd)

Cycle No.	STATION NO. -20	0	25	50	80	100	130	170	200	225	250	275	300
174	-	-	-	-	-	.080	-	-	-	.020	-	-	-
175	-	-	-	-	.088	-	-	-	-	-	.016	-	-
176	-	-	-	.092	-	-	-	-	-	-	-	.011	-
177	-	-	.058	-	-	-	-	-	-	-	-	-	.007
180	.011	.022	-	.094	.082	.082	.062	.046	.028	.022	.018	.009	.007

TABLE IX-12

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 6 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 5,500 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration on 913 ppm

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
0	-	-	-	.024	-							
1	-	.000	.001	.013	.002							
2	-	.001	.002	-	.002	-						
3	-	-	.004	.019	-	-						
4	-	.001	-	-	.008	-						
5	-	-	.008	-	-	.000						
6	-	.003	-	.028	-	-						
7	-	-	-	-	.016	-						
8	-	-	.013	-	-	.004						
9	-	.002	-	.048	-	-						
10	-	-	-	-	.025	-						
11	-	-	.015	-	-	.008						
12	-	.004	-	.057	-	-						
13	-	-	-	-	.030	-						
14	-	-	.020	-	-	.014	-					
15	-	.002	-	.064	-	-	-					
16	.000	-	-	-	.042	-	-					
17	-	-	.020	-	-	.015	.003					
18	-	.005	-	.068	-	-	-					
19	.002	-	-	-	.043	-	-					
20	-	-	-	-	-	.023	.004					
21	-	-	.026	.073	-	-	-					
22	-	.005	-	-	.051	-	-					
23	.001	-	-	-	-	.028	.005	-				
24	-	-	-	.073	-	-	-	-				
25	-	-	.025	-	.055	-	-	-				
26	-	.005	-	-	-	.028	.009	.004				
27	.000	-	-	.074	-	-	-	-				
28	-	-	-	-	.060	-	-	-				
29	-	-	.030	-	-	.036	.013	.005				
30	-	.009	-	-	-	-	.013	.005				
31	.000	-	-	-	-	-	.015	-				
32	-	-	-	.085	-	-	-	-				
33	-	-	.031	-	.066	-	-	-	-			
34	-	.008	-	-	-	.046	-	-	-			

TABLE IX-12 (cont'd)

Cycle No.	STATION NO.											
	0	25	50	80	100	130	170	200	225	250	275	300
35	.001	-	-	-	-	-	.018	-	-			
36	-	-	-	-	-	-	-	.009	.004			
37	-	-	-	.081	.071	-	-	-	-			
38	-	-	.034	-	-	.056	-	-	-			
39	-	.009	-	-	-	-	.022	-	-			
40	.001	-	-	-	-	-	-	.008	-	-		
41	-	-	-	-	-	-	-	-	.005	.002		
42	-	-	-	.077	-	-	-	-	-	.003		
43	-	-	.027	-	.062	-	-	-	-	-		
44	-	.011	-	-	-	.051	-	-	-	-		
45	.000	-	-	-	-	-	.031	-	-	-		
46	-	-	-	-	-	-	-	.015	-	-	-	
47	-	-	-	.067	-	-	-	-	.010	-	-	
48	-	-	.033	-	-	-	-	-	-	.004	-	
49	-	.010	-	-	-	-	-	-	-	-	.002	
50	.001	-	-	-	.069	-	-	-	-	-	-	
51	-	-	-	-	-	.067	-	-	-	-	-	
52	-	-	-	.072	-	-	.035	-	-	-	-	
53	-	-	.025	-	-	-	-	.018	-	-	-	
54	-	.011	-	-	-	-	-	-	.013	-	-	
55	.001	-	-	-	-	-	-	-	-	.008	-	
56	-	-	-	-	-	-	-	-	-	-	.004	
57	-	-	-	.070	.073	-	-	-	-	-	-	
58	-	-	.031	-	-	.064	-	-	-	-	-	
59	-	.011	-	-	-	-	.037	-	-	-	-	
60	.001	-	-	-	-	-	-	.024	-	-	-	
61	-	-	-	-	-	-	-	-	.015	-	-	-
62	-	-	-	.088	-	-	-	-	-	.009	-	-
63	-	-	.041	-	-	-	-	-	-	-	.009	-
64	-	.012	-	-	-	-	-	-	-	-	-	.003
65	.002	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	.066	-	-	-	-	-	-
67	-	-	-	.082	-	-	.042	-	-	-	-	-
68	-	-	.032	-	-	-	-	.026	-	-	-	-
69	-	.008	-	-	-	-	-	-	.020	-	-	-
70	.001	-	-	-	-	-	-	-	-	.011	-	-
71	-	-	-	-	-	-	-	-	-	-	.008	-
72	-	-	-	-	.069	-	-	-	-	-	-	.002
73	-	-	-	.096	-	.077	-	-	-	-	-	-
74	-	-	.032	-	-	-	.081	-	-	-	-	-
75	-	.007	-	-	-	-	-	.030	-	-	-	-
76	.000	-	-	-	-	-	-	-	.023	-	-	-
77	-	-	-	-	-	-	-	-	-	.014	-	-
78	-	-	-	-	.081	-	-	-	-	-	.008	-
79	-	-	-	.090	-	-	-	-	-	-	-	.004
80	-	-	.036	-	-	.076	-	-	-	-	-	-
81	-	.008	-	-	-	-	.054	-	-	-	-	-
82	.000	-	-	-	-	-	-	.031	-	-	-	-
83	-	-	-	-	-	-	-	-	.025	-	-	-
84	-	-	-	-	.084	-	-	-	-	.015	-	-
85	-	-	-	.088	-	-	-	-	-	-	.009	-
86	-	-	.032	-	-	-	-	-	-	-	-	.004
87	-	.011	-	-	-	.079	-	-	-	-	-	-
88	.001	-	-	-	-	-	.048	-	-	-	-	-
89	-	-	-	-	-	-	-	.035	-	-	-	-

TABLE IX-12 (cont'd)

Cycle No.	STATION NO.											
	0	25	50	80	100	130	170	200	225	250	275	300
90	-	-	-	-	.087	-	-	-	.018	-	-	-
91	-	-	-	.087	-	-	-	-	-	.015	-	-
92	-	-	.033	-	-	-	-	-	-	-	.012	-
93	-	.010	-	-	-	-	-	-	-	-	-	.008
94	.000	-	-	-	-	.084	-	-	-	-	-	-
95	-	-	-	-	-	-	.054	-	-	-	-	-
96	-	-	-	-	.081	-	-	.039	-	-	-	-
97	-	-	-	.096	-	-	-	-	.032	-	-	-
98	-	-	.034	-	-	-	-	-	-	.020	-	-
99	-	.011	-	-	-	-	-	-	-	-	.013	-
100	.001	-	-	-	-	-	-	-	-	-	-	.010
101	-	-	-	-	-	.082	-	-	-	-	-	-
102	-	-	-	-	.084	-	.062	-	-	-	-	-
103	-	-	-	.083	-	-	-	.039	-	-	-	-
104	-	-	.035	-	-	-	-	-	.033	-	-	-
105	-	.012	-	-	-	-	-	-	-	.016	-	-
106	.001	-	-	-	-	-	-	-	-	-	.014	-
107	-	-	-	-	-	-	-	-	-	-	-	.007
108	-	-	-	-	.087	.076	-	-	-	-	-	-
109	-	-	-	.085	-	-	.061	-	-	-	-	-
110	-	-	.033	-	-	-	-	.043	-	-	-	-
111	-	.011	-	-	-	-	-	-	.033	-	-	-
112	.001	-	-	-	-	-	-	-	-	.020	-	-
113	-	-	-	-	-	-	-	-	-	-	.015	-
114	-	-	-	-	.092	-	-	-	-	-	-	.010
115	-	-	-	.093	-	.082	-	-	-	-	-	-
116	-	-	.036	-	-	-	.066	-	-	-	-	-
117	-	.009	-	-	-	-	-	.044	-	-	-	-
118	.000	-	-	-	-	-	-	-	.037	-	-	-
119	-	-	-	-	-	-	-	-	-	.024	-	-
120	-	-	-	-	.084	-	-	-	-	-	.018	-
121	-	-	-	.092	-	-	-	-	-	-	-	.012
122	-	-	.038	-	-	.084	-	-	-	-	-	-
123	-	.010	-	-	-	-	.068	-	-	-	-	-
124	.001	-	-	-	-	-	-	.047	-	-	-	-
125	-	-	-	-	-	-	-	-	.036	-	-	-
126	-	-	-	-	.091	-	-	-	-	.025	-	-
127	-	-	-	.090	-	-	-	-	-	-	.021	-
128	-	-	.031	-	-	-	-	-	-	-	-	.008
129	-	.013	-	-	-	.090	-	-	-	-	-	-
130	.000	-	-	-	-	-	.066	-	-	-	-	-
131	-	-	-	-	-	-	-	.046	-	-	-	-
132	-	-	-	-	.090	-	-	-	.035	-	-	-
133	-	-	-	.096	-	-	-	-	-	.024	-	-
134	-	-	.037	-	-	-	-	-	-	-	.020	-
135	-	.012	-	-	-	-	-	-	-	-	-	.010
136	.000	-	-	-	-	.081	-	-	-	-	-	-
137	-	-	-	-	-	-	.060	-	-	-	-	-
138	-	-	-	-	.080	-	-	.044	-	-	-	-
139	-	-	-	.097	-	-	-	-	.033	-	-	-
140	-	-	.050	-	-	-	-	-	-	.023	-	-
141	-	.016	-	-	-	-	-	-	-	-	.019	-
142	.000	-	-	-	-	-	-	-	-	-	-	.016
143	-	-	-	-	-	.076	-	-	-	-	-	-
144	-	-	-	-	.073	-	.061	-	-	-	-	-

TABLE IX-12 (cont'd)

Cycle No.	0	25	50	80	100	130	170	200	225	250	275	300
	STATION NO.											
145	-	-	-	.088	-	-	-	.045	-	-	-	-
146	-	-	.042	-	-	-	-	-	.039	-	-	-
147	-	.010	-	-	-	-	-	-	-	.025	-	-
148	.001	-	-	-	-	-	-	-	-	-	.016	-
149	-	-	-	-	-	-	-	-	-	-	-	.010
150	-	-	-	-	.089	.079	-	-	-	-	-	-
151	-	-	-	.083	-	-	.064	-	-	-	-	-
152	-	-	.032	-	-	-	-	.039	-	-	-	-
153	-	.010	-	-	-	-	-	-	.042	-	-	-
154	.001	-	-	-	-	-	-	-	-	.030	-	-
155	-	-	-	-	-	-	-	-	-	-	.020	-
156	-	-	-	-	.089	-	-	-	-	-	-	.012
157	-	-	-	.090	-	.085	-	-	-	-	-	-
158	-	-	.041	-	-	-	.064	-	-	-	-	-
159	-	.010	-	-	-	-	-	.049	-	-	-	-
160	.002	-	-	-	-	-	-	-	.043	-	-	-
161	-	-	-	-	-	-	-	-	-	.028	-	-
162	-	-	-	-	.081	-	-	-	-	-	.020	-
163	-	-	-	.092	-	-	-	-	-	-	-	.013
164	-	-	.031	-	-	.080	-	-	-	-	-	-
165	-	.012	-	-	-	-	.064	-	-	-	-	-
166	.001	-	-	-	-	-	-	.057	-	-	-	-
167	-	-	-	-	-	-	-	-	.043	-	-	-
168	-	-	-	-	.084	-	-	-	-	.026	-	-
169	-	-	-	.085	-	-	-	-	-	-	.022	-
170	-	-	.038	-	-	-	-	-	-	-	-	.014
171	-	.012	-	-	-	.089	-	-	-	-	-	-
172	.000	-	-	-	-	-	.070	-	-	-	-	-
173	-	-	-	-	-	-	-	.050	-	-	-	-
174	-	-	-	-	.092	-	-	-	.046	-	-	-
175	-	-	-	.093	-	-	-	-	-	.027	-	-
176	-	-	.041	-	-	-	-	-	-	-	.023	-
177	-	.011	-	-	-	-	-	-	-	-	-	.015
180	.001	-	.035	.079	.081	.077	.061	.046	.035	.031	.024	.016

TABLE IX-13

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 7 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 4,500 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	-35	-20	0	25	50	80	100	130	170	200	225	250	275	300
	STATION NO.													
1	-	-	-	.009	-	.001	-							
2	-	-	-	-	.012	-	.001	-						
3	-	-	-	.015	-	.001	-	-						
4	-	-	.003	-	-	-	.001	-						
5	-	-	-	-	.025	-	-	.002						
6	-	-	-	.026	-	-	-	-						
7	-	-	.007	-	-	.004	-	-	-					

TABLE IX-13 (cont'd)

Cycle No.	STATION NO. -35	-20	0	25	50	80	100	130	170	200	225	250	275	300
8	-	-	-	-	.031	-	.002	-	-	-				
9	-	-	-	.038	-	-	-	.001	-	-	-			
10	-	-	.011	-	-	-	-	-	.000	-	-			
11	-	-	-	-	.045	-	-	-	-	.002	-			
12	-	-	-	.048	-	-	-	-	-	-	.002			
13	-	-	.016	-	-	.012	-	-	-	-	-			
14	-	.004	-	-	-	-	.009	-	-	-	-			
15	-	-	-	-	.058	-	-	.003	-	-	-			
16	-	-	-	.056	-	-	-	-	.002	-	-			
17	-	-	.022	-	-	-	-	-	-	.002	-			
18	-	.007	-	-	-	-	-	-	-	-	.002			
19	-	-	-	-	.064	.023	-	-	-	-	-			
20	-	-	-	.057	-	-	.095	-	-	-	-			
21	-	-	.022	-	-	-	-	.005	-	-	-			
22	-	.005	-	-	-	-	-	-	.003	-	-			
23	-	-	-	-	.072	-	-	-	-	.002	-			
24	-	-	-	.066	-	-	-	-	-	-	.002			
25	-	-	.027	-	-	.037	-	-	-	-	-			
26	-	.008	-	-	-	-	.087	-	-	-	-			
27	-	-	-	-	.078	-	-	.010	-	-	-			
28	-	-	-	.066	-	-	-	-	.004	-	-	-		
29	-	-	.024	-	-	-	-	-	-	.003	-	-		
30	-	.011	-	-	-	-	-	-	-	-	.002	-		
31	-	-	-	-	-	.038	-	-	-	-	-	.002		
32	-	-	-	-	.084	-	.094	-	-	-	-	-		
33	-	-	-	.070	-	-	-	.015	-	-	-	-		
34	-	-	.027	-	-	-	-	-	.007	-	-	-		
35	-	.010	-	-	-	-	-	-	-	.003	-	-	-	
36	-	-	-	-	-	.047	-	-	-	-	.002	-	-	
37	-	-	-	-	.091	-	-	-	-	-	-	-	.002	
38	-	-	-	.071	-	-	-	-	-	-	-	-	-	
39	-	-	.027	-	-	-	.096	-	-	-	-	-	-	
40	-	.011	-	-	-	-	-	.016	-	-	-	-	-	
41	-	-	-	-	-	-	.038	-	.010	-	-	-		
42	-	-	-	-	-	.061	-	-	-	.004	-	-	-	
43	-	-	-	-	.090	-	-	-	-	-	.004	-	-	
44	-	-	-	.082	-	-	-	-	-	-	-	.002	-	
45	-	-	.028	-	-	-	-	-	-	-	-	-	.002	
46	-	.013	-	-	-	-	-	.024	-	-	-	-	-	
47	-	-	-	-	-	-	.043	-	.010	-	-	-	-	
48	-	-	-	-	-	.065	-	-	-	.007	-	-	-	
49	-	-	-	-	.089	-	-	-	-	-	.005	-	-	
50	-	-	-	.081	-	-	-	-	-	-	-	.003	-	
51	-	-	.030	-	-	-	-	-	-	-	-	-	.001	
52	-	.009	-	-	-	-	-	-	-	-	-	-	-	
53	-	-	-	-	-	-	.053	.030	-	-	-	-	-	
54	-	-	-	-	-	.061	-	-	.016	-	-	-	-	
55	-	-	-	-	.094	-	-	-	-	.008	-	-	-	
56	-	-	-	.097	-	-	-	-	-	-	.007	-	-	-
57	-	-	.037	-	-	-	-	-	-	-	-	.004	-	-
58	-	.012	-	-	-	-	-	-	-	-	-	-	.004	-
59	-	-	-	-	-	-	.058	-	-	-	-	-	-	.002
60	-	-	-	-	-	.078	-	.035	-	-	-	-	-	-
61	-	-	-	-	.068	-		-	.020	-	-	-	-	-
62	-	-	-	.082	-	-	-	-	-	.007	-	-	-	-

TABLE IX-13 (cont'd)

Cycle No.	STATION NO. -35	-20	0	25	50	80	100	130	170	200	225	250	275	300
63	-	-	.043	-	-	-	-	-	-	-	.004	-	-	-
64	.005	.021	-	-	-	-	-	-	-	-	-	.003	-	-
65	-	-	-	-	-	-	.072	-	-	-	-	-	.001	-
66	-	-	-	-	-	.069	-	-	-	-	-	-	-	.002
67	-	-	-	-	.099	-	-	.037	-	-	-	-	-	-
68	-	-	-	.097	-	-	-	-	.021	-	-	-	-	-
69	-	-	.038	-	-	-	-	-	-	.010	-	-	-	-
70	.004	.018	-	-	-	-	-	-	-	-	.008	-	-	-
71		-	-	-	-	-	.060	-	-	-	-	.004	-	-
72	-	-	-	-	-	.077	-	-	-	-	-	-	.004	-
73	-	-	-	-	.095	-	-	-	-	-	-	-	-	.002
74	-	-	-	.090	-	-	-	.037	-	-	-	-	-	-
75	-	-	.038	-	-	-	-	-	.023	-	-	-	-	-
76	.002	.015	-	-	-	-	-	-	-	.015	-	-	-	-
77	-	-	-	-	-	-	.065	-	-	-	.007	-	-	-
78	-	-	-	-	-	.080	-	-	-	-	-	.004	-	-
79	-	-	-	-	.102	-	-	-	-	-	-	-	.004	-
80	-	-	-	.088	-	-	-	-	-	-	-	-	-	.002
81	-	-	.041	-	-	-	-	.043	-	-	-	-	-	-
82	.005	.018	-	-	-	-	-	-	.026	-	-	-	-	-
83	-	-	-	-	-	-	.055	-	-	.012	-	-	-	-
84	-	-	-	-	-	.088	-	-	-	-	.008	-	-	-
85	-	-	-	-	.110	-	-	-	-	-	-	.007	-	-
86	-	-	-	.084	-	-	-	-	-	-	-	-	.003	-
87	-	-	.045	-	-	-	-	-	-	-	-	-	-	.004
88	.003	.019	-	-	-	-	-	.048	-	-	-	-	-	-
89	-	-	-	-	-	-	.074	-	.028	-	-	-	-	-
90	-	-	-	-	-	.080	-	-	-	.018	-	-	-	-
91	-	-	-	-	.103	-	-	-	-	-	.014	-	-	-
92	-	-	-	.084	-	-	-	-	-	-	-	.010	-	-
93	-	-	.044	-	-	-	-	-	-	-	-	-	.005	-
94	.005	.018	-	-	-	-	-	-	-	-	-	-	-	.004
95	-	-	-	-	-	-	.084	.050	-	-	-	-	-	-
96	-	-	-	-	-	.080	-	-	.032	-	-	-	-	-
97	-	-	-	-	.103	-	-	-	-	.020	-	-	-	-
98	-	-	-	.100	-	-	-	-	-	-	.012	-	-	-
99	-	-	.046	-	-	-	-	-	-	-	-	.008	-	-
100	.004	.020	-	-	-	-	-	-	-	-	-	-	.004	-
101	-	-	-	-	-	-	.079	-	-	-	-	-	-	.002
102	-	-	-	-	-	.100	-	.057	-	-	-	-	-	-
103	-	-	-	-	.107	-	-	-	.035	-	-	-	-	-
104	-	-	-	.089	-	-	-	-	-	.018	-	-	-	-
105	-	-	.044	-	-	-	-	-	-	-	.014	-	-	-
106	.004	.020	-	-	-	-	-	-	-	-	-	.012	-	-
107	-	-	-	-	-	-	.089	-	-	-	-	-	.004	-
108	-	-	-	-	-	.094	-	-	-	-	-	-	-	.003
109	-	-	-	-	.099	-	-	.055	-	-	-	-	-	-
110	-	-	-	.095	-	-	-	-	.038	-	-	-	-	-
111	-	-	.042	-	-	-	-	-	-	.022	-	-	-	-
112	.004	.020	-	-	-	-	-	-	-	-	.015	-	-	-
113	-	-	-	-	-	-	.072	-	-	-	-	.009	-	-
114	-	-	-	-	-	.091	-	-	-	-	-	-	.007	-
115	-	-	-	-	.112	-	-	-	-	-	-	-	-	.003
116	-	-	-	.096	-	-	-	.059	-	-	-	-	-	-
117	-	-	.042	-	-	-	-	-	.038	-	-	-	-	-

TABLE IX-13 (cont'd)

STATION NO.

Cycle No.	-35	-20	0	25	50	80	100	130	170	200	225	250	275	300
118	.008	.021	-	-	-	-	-	-	-	.027	-	-	-	-
119	-	-	-	-	-	-	.091	-	-	-	.018	-	-	-
120	-	-	-	-	-	.100	-	-	-	-	-	.011	-	-
121	-	-	-	-	.108	-	-	-	-	-	-	-	.004	-
122	-	-	-	.066	-	-	-	-	-	-	-	-	-	.004
123	-	-	.045	-	-	-	-	.061	-	-	-	-	-	-
124	.007	.015	-	-	-	-	-	-	.041	-	-	-	-	-
125	-	-	-	-	-	-	.095	-	-	.025	-	-	-	-
126	-	-	-	-	-	.101	-	-	-	-	.016	-	-	-
127	-	-	-	-	.107	-	-	-	-	-	-	.012	-	-
128	-	-	-	.094	-	-	-	-	-	-	-	-	.007	-
129	-	-	.048	-	-	-	-	-	-	-	-	-	-	.003
130	.004	.016	-	-	-	-	-	.066	-	-	-	-	-	-
131	-	-	-	-	-	-	.087	-	.044	-	-	-	-	-
132	-	-	-	-	-	.102	-	-	-	.025	-	-	-	-
133	-	-	-	-	.110	-	-	-	-	-	.014	-	-	-
134	-	-	-	.095	-	-	-	-	-	-	-	.009	-	-
135	-	-	.037	-	-	-	-	-	-	-	-	-	.009	-
136	.004	.018	-	-	-	-	-	-	-	-	-	-	-	.004
137	-	-	-	-	-	-	.094	.068	-	-	-	-	-	-
138	-	-	-	-	-	.111	-	-	.049	-	-	-	-	-
139	-	-	-	-	.120	-	-	-	-	.031	-	-	-	-
140	-	-	-	.099	-	-	-	-	-	-	.021	-	-	-
141	-	-	.038	-	-	-	-	-	-	-	-	.013	-	-
142	.008	.022	-	-	-	-	-	-	-	-	-	-	.010	-
143	-	-	-	-	-	-	.096	-	-	-	-	-	-	.004
144	-	-	-	-	-	.107	-	.072	-	-	-	-	-	-
145	-	-	-	-	.125	-	-	-	.046	-	-	-	-	-
146	-	-	-	.106	-	-	-	-	-	.030	-	-	-	-
147	-	-	.054	-	-	-	-	-	-	-	.018	-	-	-
148	.007	.021	-	-	-	-	-	-	-	-	-	.013	-	-
149	-	-	-	-	-	-	.093	-	-	-	-	-	.011	-
150	-	-	-	-	-	.105	-	-	-	-	-	-	-	.008
151	-	-	-	-	.119	-	-	.070	-	-	-	-	-	-
152	-	-	-	.101	-	-	-	-	.050	-	-	-	-	-
153	-	-	.046	-	-	-	-	-	-	.031	-	-	-	-
154	.005	.023	-	-	-	-	-	-	-	-	.024	-	-	-
155	-	-	-	-	-	-	.090	-	-	-	-	.014	-	-
156	-	-	-	-	-	.100	-	-	-	-	-	-	.011	-
157	-	-	-	-	.130	-	-	-	-	-	-	-	-	.005
158	-	-	-	.104	-	-	-	.071	-	-	-	-	-	-
159	-	-	.054	-	-	-	-	-	.050	-	-	-	-	-
160	.008	.019	-	-	-	-	-	-	-	.032	-	-	-	-
161	-	-	-	-	-	-	.096	-	-	-	.022	-	-	-
162	-	-	-	-	-	.108	-	-	-	-	-	.012	-	-
163	-	-	-	-	.137	-	-	-	-	-	-	-	.012	-
164	-	-	-	.110	-	-	-	-	-	-	-	-	-	.010
165	-	-	.055	-	-	-	-	.070	-	-	-	-	-	-
166	.008	.020	-	-	-	-	-	-	.051	-	-	-	-	-
167	-	-	-	-	-	-	.100	-	-	.009	-	-	-	-
168	-	-	-	-	-	.111	-	-	-	-	.027	-	-	-
169	-	-	-	-	.125	-	-	-	-	-	-	.016	-	-
170	-	-	-	.104	-	-	-	-	-	-	-	-	.013	-
171	-	-	.043	-	-	-	-	-	-	-	-	-	-	.008
172	.008	.021	-	-	-	-	-	.074	-	-	-	-	-	-

TABLE IX-13 (cont'd)

Cycle No.	STATION NO. -35	-20	0	25	50	80	100	130	170	200	225	250	275	300
173	-	-	-	-	-	-	.104	-	.054	-	-	-	-	-
174	-	-	-	-	-	.106	-	-	-	.035	-	-	-	-
175	-	-	-	-	.126	-	-	-	-	-	.025	-	-	-
176	-	-	-	.104	-	-	-	-	-	-	-	.019	-	-
177	-	-	.051	-	-	-	-	-	-	-	-	-	.011	-
180	-	.019	.044	-	.103	.105	.082	.071	.049	.031	.022	.019	.088	.005

TABLE IX-14

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 7 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 4,500 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
0	-	-	-	.001	-	-						
1	-	.001	-	.001	.001	-						
2	-	-	.003	-	.002	.000						
3	-	.001	-	.025	-	-	-					
4	-	-	-	-	.002	-	-					
5	-	-	.012	-	-	.002	-					
6	-	.002	-	-	-	-	.001					
7	-	-	-	.035	-	-	-					
8	-	-	.016	-	.016	-	-	-				
9	-	.004	-	-	-	.005	-	-	-			
10	-	-	-	-	-	-	.002	-	-			
11	-	-	.024	-	-	-	-	.002	-			
12	-	.008	-	-	-	-	-	-	.002			
13	-	-	-	.059	-	-	-	-	-			
14	-	-	-	-	.038	-	-	-	-			
15	-	-	.031	-	-	.014	-	-	-			
16	-	.011	-	-	-	-	.003	-	-			
17	-	-	-	-	-	-	-	.002	-			
18	-	-	-	-	-	-	-	-	.002			
19	-	-	.032	.070	-	-	-	-	-			
20	-	.012	-	-	.101	-	-	-	-			
21	.000	-	-	-	-	.023	-	-	-			
22	-	-	-	-	-	-	.007	-	-			
23	-	-	.042	-	-	-	-	.002	-			
24	-	.013	-	-	-	-	-	-	.002			
25	.001	-	-	.080	-	-	-	-	-			
26	-	-	-	-	.104	-	-	-	-			
27	-	-	.039	-	-	.034	-	-	-			
28	-	.015	-	-	-	-	.012	-	-	-		
29	.000	-	-	-	-	-	-	.005	-	-		
30	-	-	-	-	-	-	-	-	.003	-		
31	-	-	-	.069	-	-	-	-	-	.002		
32	-	-	.043	-	.111	-	-	-	-	-		
33	-	.019	-	-	-	.038	-	-	-	-		
34	.001	-	-	-	-	-	.018	-	-	-		

TABLE IX-14 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
35	-	-	-	-	-	-	-	.008	-	-	-	
36	-	-	-	.092	-	-	-	-	.003	-	-	
37	-	-	.046	-	-	-	-	-	-	-	-	
38	-	.020	-	-	-	-	-	-	-	-	.003	
39	.001	-	-	-	.106	-	-	-	-	-	-	
40	-	-	-	-	-	.050	-	-	-			
41	-	-	-	-	.076	-	.020	-	-	-		
42	-	-	-	.092	-	-	-	.012	-	-	-	
43	-	-	.050	-	-	-	-	-	.010	-	-	
44	-	.020	-	-	-	-	-	-	-	.004	-	
45	.002	-	-	-	-	-	-	-	-	-	.004	
46	-	-	-	-	-	.057	-	-	-	-	-	
47	-	-	-	-	.078	-	.023	-	-	-	-	
48	-	-	-	.089	-	-	-	.014	-	-	-	
49	-	-	.053	-	-	-	-	-	.011	-	-	-
50	-	.015	-	-	-	-	-	-	-	.008	-	-
51	.001	-	-	-	-	-	-	-	-	-	.007	-
52	-	-	-	-	-	-	-	-	-	-	-	.004
53	-	-	-	-	.085	.064	-	-	-	-	-	-
54	-	-	-	.120	-	-	.031	-	-	-	-	-
55	-	-	.058	-	-	-	-	.018	-	-	-	-
56	-	.021	-	-	-	-	-	-	.014	-	-	-
57	.002	-	-	-	-	-	-	-	-	.009	-	-
58	-	-	-	-	-	-	-	-	-	-	.005	-
59	-	-	-	-	.093	-	-	-	-	-	-	.003
60	-	-	-	.100	-	.069	-	-	-	-	-	-
61	-	-	.050	-	-	-	.031	-	-	-	-	-
62	-	.022	-	-	-	-	-	.021	-	-	-	-
63	.002	-	-	-	-	-	-	-	.014	-	-	-
64	-	-	-	-	-	-	-	-	-	.009	-	-
65	-	-	-	-	.101	-	-	-	-	-	.007	-
66	-	-	-	.100	-	-	-	-	-	-	-	.002
67	-	-	.055	-	-	.078	-	-	-	-	-	-
68	-	.023	-	-	-	-	.039	-	-	-	-	-
69	.002	-	-	-	-	-	-	.026	-	-	-	-
70	-	-	-	-	-	-	-	-	.015	-	-	-
71	-	-	-	-	.092	-	-	-	-	.011	-	-
72	-	-	-	.116	-	-	-	-	-	-	.004	-
73	-	-	.059	-	-	-	-	-	-	-	-	.005
74	-	.023	-	-	-	.076	-	-	-	-	-	-
75	.001	-	-	-	-	-	.046	-	-	-	-	-
76	-	-	-	-	-	-	-	.032	-	-	-	-
77	-	-	-	-	.088	-	-	-	.020	-	-	-
78	-	-	-	.084	-	-	-	-	-	.012	-	-
79	-	-	.058	-	-	-	-	-	-	-	.004	-
80	-	.023	-	-	-	-	-	-	-	-	-	.007
81	.002	-	-	-	-	.082	-	-	-	-	-	-
82	-	-	-	-	-	-	.047	-	-	-	-	-
83	-	-	-	-	.100	-	-	.032	-	-	-	-
84	-	-	-	.115	-	-	-	-	.024	-	-	-
85	-	-	.055	-	-		-	-	-	.012	-	-
86	-	.023	-	-	-	-	-	-	-	-	.012	-
87	.003	-	-	-	-	-	-	-	-	-	-	.007
88	-	-	-	-	-	.087	-	-	-			
89	-	-	-	-	.089	-	.057	-	-	-		

TABLE IX-14 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
90	-	-	-	.113	-	-	-	.032	-	-	-	
91	-	-	.058	-	-	-	-	-	.027	-	-	-
92	-	.028	-	-	-	-	-	-	-	.020	-	-
93	.001	-	-	-	-	-	-	-	-	-	.012	-
94	-	-	-	-	-	-	-	-	-	-	-	.044
95	-	-	-	-	.105	.089	-	-	-	-	-	-
96	-	-	-	.107	-	-	.061	-	-	-	-	-
97	-	-	.054	-	-	-	-	.034	-	-	-	-
98	-	.027	-	-	-	-	-	-	.028	-	-	-
99	.003	-	-	-	-	-	-	-	-	.020	-	-
100	-	-	-	-	-	-	-	-	-	-	.013	-
101	-	-	-	-	.104	-	-	-	-	-	-	.007
102	-	-	-	.124	-	.093	-	-	-	-	-	-
103	-	-	.072	-	-	-	.061	-	-	-	-	-
104	-	.024	-	-	-	-	-	.038	-	-	-	-
105	.004	-	-	-	-	-	-	-	.033	-	-	-
106	-	-	-	-	-	-	-	-	-	.021	-	-
107	-	-	-	-	.102	-	-	-	-	-	.012	-
108	-	-	-	.112	-	-	-	-	-	-	-	.008
109	-	-	.064	-	-	.090	-	-	-	-	-	-
110	-	.028	-	-	-	-	.069	-	-	-	-	-
111	.003	-	-	-	-	-	-	.042	-	-	-	-
112	-	-	-	-	-	-	-	-	.031	-	-	-
113	-	-	-	-	.095	-	-	-	-	.022	-	-
114	-	-	-	.125	-	-	-	-	-	-	.015	-
115	-	-	.061	-	-	-	-	-	-	-	-	.010
116	-	.031	-	-	-	.100	-	-	-	-	-	-
117	.004	-	-	-	-	-	.068	-	-	-	-	-
118	-	-	-	-	-	-	-	.046	-	-	-	-
119	-	-	-	-	.114	-	-	-	.036	-	-	-
120	-	-	-	.119	-	-	-	-	-	.023	-	-
121	-	-	.062	-	-	-	-	-	-	-	.019	-
122	-	.028	-	-	-	-	-	-	-	-	-	.013
123	.003	-	-	-	-	.096	-	-	-	-	-	-
124	-	-	-	-	-	-	.066	-	-	-	-	-
125	-	-	-	-	.101	-	-	.049	-	-	-	-
126	-	-	-	.128	-	-	-	-	.036	-	-	-
127	-	-	.060	-	-	-	-	-	-	.023	-	-
128	-	.022	-	-	-	-	-	-	-	-	.016	-
129	.004	-	-	-	-	-	-	-	-	-	-	.011
130	-	-	-	-	-	.094	-	-	-	-	-	-
131	-	-	-	-	.104	-	.059	-	-	-	-	-
132	-	-	-	.126	-	-	-	.044	-	-	-	-
133	-	-	.038	-	-	-	-	-	.034	-	-	-
134	-	.026	-	-	-	-	-	-	-	.024	-	-
135	.003	-	-	-	-	-	-	-	-	-	.018	-
136	-	-	-	-	-	-	-	-	-	-	-	.013
137	-	-	-	-	.111	.091	-	-	-	-	-	-
138	-	-	-	.116	-	-	.071	-	-	-	-	-
139	-	-	.062	-	-	-	-	.054	-	-	-	-
140	-	.026	-	-	-	-	-	-	.039	-	-	-
141	.004	-	-	-	-	-	-	-	-	.028	-	-
142	-	-	-	-	-	-	-	-	-	-	.021	-
143	-	-	-	-	.106	-	-	-	-	-	-	.011
144	-	-	-	.115	-	.105	-	-	-	-	-	-

TABLE IX-14 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
145	-	-	.068	-	-	-	.071	-	-	-	-	-
146	-	.027	-	-	-	-	-	.055	-	-	-	-
147	.004	-	-	-	-	-	-	-	.043	-	-	-
148	-	-	-	-	-	-	-	-	-	.032	-	-
149	-	-	-	-	.111	-	-	-	-	-	.023	-
150	-	-	-	.126	-	-	-	-	-	-	-	.016
151	-	-	.069	-	-	.104	-	-	-	-	-	-
152	-	.032	-	-	-	-	.071	-	-	-	-	-
153	.004	-	-	-	-	-	-	.056	-	-	-	-
154	-	-	-	-	-	-	-	-	.043	-	-	-
155	-	-	-	-	.114	-	-	-	-	.028	-	-
156	-	-	-	.129	-	-	-	-	-	-	.023	-
157	-	-	.064	-	-	-	-	-	-	-	-	.015
158	-	.030	-	-	-	.104	-	-	-	-	-	-
159	.004	-	-	-	-	-	.023	-	-	-	-	-
160	-	-	-	-	-	-	-	.054	-	-	-	-
161	-	-	-	-	.118	-	-	-	.046	-	-	-
162	-	-	-	.139	-	-	-	-	-	.027	-	-
163	-	-	.064	-	-	-	-	-	-	-	.026	-
164	-	.031	-	-	-	-	-	-	-	-	-	.013
165	.004	-	-	-	-	.099	-	-	-	-	-	-
166	-	-	-	-	-	-	.079	-	-	-	-	-
167	-	-	-	-	.122	-	-	.056	-	-	-	-
168	-	-	-	.134	-	-	-	-	.046	-	-	-
169	-	-	.069	-	-	-	-	-	-	.030	-	-
170	-	.031	-	-	-	-	-	-	-	-	.027	-
171	.003	-	-	-	-	-	-	-	-	-	-	.015
172	-	-	-	-	-	.102	-	-	-	-	-	-
173	-	-	-	-	.122	-	.079	-	-	-	-	-
174	-	-	-	.094	-	-	-	.061	-	-	-	-
175	-	-	.067	-	-	-	-	-	.041	-	-	-
176	-	.028	-	-	-	-	-	-	-	.025	-	-
177	.002	-	-	-	-	-	-	-	-	-	.021	-
180	.001	-	.067	.114	.119	.099	.082	.051	.048	.037	.027	.019

TABLE IX-15

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 8 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 7,000 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. -20	0	25	50	80	100	130	170	200	225	250	275	300
1	-	-	.002	-	-								
2	-	-	-	.003	-								
3	-	-	.010	-	.001								
4	-	-	-	.012	-	-							
5	-	-	.015	-	-	-							
6	-	.001	-	-	.001	-							
7	-	-	-	.024	-	.000							

TABLE IX-15 (cont'd)

Cycle No.	STATION NO. -20	0	25	50	80	100	130	170	200	225	250	275	300
8	-	-	.023	-	-	-	-						
9	-	.004	-	-	.005	-	-						
10	-	-	-	.032	-	.002	-						
11	-	-	.031	-	-	-	.001						
12	-	.005	-	-	-	-	-						
13	-	-	-	.042	.011	-	-						
14	-	-	.033	-	-	.007	-						
15	-	.005	-	-	-	-	.002						
16	-	-	-	.043	-	-	-						
17	-	-	.027	-	.022	-	-	-					
18	-	.007	-	-	-	.014	-	-					
19	-	-	-	.048	-	-	.005	-					
20	-	-	.033	-	-	-	-	.002					
21	-	.007	-	-	-	-	-	-					
22	-	-	-	.048	.034	-	-	-					
23	-	-	.035	-	-	.022	-	-	-				
24	-	.008	-	-	-	-	.008	-	-				
25	-	-	-	.050	-	-	-	.004	-				
26	-	-	.042	-	-	-	-	-	.002				
27	-	.011	-	-	.032	-	-	-	-				
28	-	-	-	.050	-	.027	-	-	-				
29	-	-	.038	-	-	-	.013	-	-				
30	-	.008	-	-	-	-	-	.005	-				
31	-	-	-	-	.041	-	-	-	.002				
32	-	-	-	.058	-	-	-	-	-				
33	-	-	.041	-	-	.031	-	-	-				
34	-	.013	-	-	-	-	.021	-	-	-			
35	-	-	-	-	.046	-	-	.009	-	-			
36	-	-	-	.053	-	-	-	-	.004	-			
37	-	-	.038	-	-	-	-	-	-	.002			
38	-	.008	-	-	-	-	-	-	-	-			
39	-	-	-	-	.050	.038	-	-	-	-			
40	-	-	-	.049	-	-	.020	-	-	-			
41	-	-	.036	-	-	-	-	.011	-	-			
42	-	.013	-	-	-	-	-	-	.005	-	-		
43	-	-	-	-	-	.045	-	-	-	.004	-		
44	-	-	-	-	.048	-	-	-	-	-	.003		
45	-	-	-	.066	-	-	-	-	-	-	-		
46	-	-	.050	-	-	-	.026	-	-	-	-		
47	-	.014	-	-	-	-	-	.013	-	-	-		
48	-	-	-	-	-	.048	-	-	.005	-	-	-	
49	-	-	-	-	.049	-	-	-	-	.003	-	-	
50	-	-	-	.077	-	-	-	-	-	-	.004	-	
51	-	-	.055	-	-	-	-	-	-	-	-	.004	
52	-	.014	-	-	-	-	-	-	-	-	-	-	
53	-	-	-	-	-	.050	.030	-	-	-	-	-	
54	-	-	-	-	.061	-	-	.018	-	-	-	-	
55	-	-	-	.071	-	-	-	-	.010	-	-	-	
56	-	-	.049	-	-	-	-	-	-	.008	-	-	-
57	-	.014	-	-	-	-	-	-	-	-	.005	-	-
58	.004	-	-	-	-	-	-	-	-	-	-	.003	-
59	-	-	-	-	-	.057	-	-	-	-	-	-	.002
60	-	-	-	-	.066	-	.034	-	-	-	-	-	-
61	-	-	-	.069	-	-	-	.022	-	-	-	-	-
62	-	-	.050	-	-	-	-	-	.012	-	-	-	-

TABLE IX-15 (cont'd)

Cycle No.	STATION NO. -20	0	25	50	80	100	130	170	200	225	250	275	300
63	-	.016	-	-	-	-	-	-	-	.008	-	-	-
64	.001	-	-	-	-	-	-	-	-	-	.005	-	-
65	-	-	-	-	-	.059	-	-	-	-	-	.004	-
66	-	-	-	-	.067	-	-	-	-	-	-	-	.003
67	-	-	-	.068	-	-	.064	-	-	-	-	-	-
68	-	-	.053	-	-	-	-	.027	-	-	-	-	-
69	-	.015	-	-	-	-	-	-	.015	-	-	-	-
70	.002	-	-	-	-	-	-	-	-	.011	-	-	-
71	-	-	-	-	-	.064	-	-	-	-	.007	-	-
72	-	-	-	-	.068	-	-	-	-	-	-	.002	-
73	-	-	-	.051	-	-	-	-	-	-	-	-	.002
74	-	-	.046	-	-	-	.039	-	-	-	-	-	-
75	-	.013	-	-	-	-	-	.027	-	-	-	-	-
76	.002	-	-	-	-	-	-	-	.015	-	-	-	-
77	-	-	-	-	-	.069	-	-	-	.010	-	-	-
78	-	-	-	-	.069	-	-	-	-	-	.008	-	-
79	-	-	-	.070	-	-	-	-	-	-	-	.005	-
80	-	-	.050	-	-	-	-	-	-	-	-	-	.003
81	-	.013	-	-	-	-	.048	-	-	-	-	-	-
82	.002	-	-	-	-	-	-	.032	-	-	-	-	-
83	-	-	-	-	-	.060	-	-	.020	-	-	-	-
84	-	-	-	-	.067	-	-	-	-	.013	-	-	-
85	-	-	-	.072	-	-	-	-	-	-	.008	-	-
86	-	-	.051	-	-	-	-	-	-	-	-	.005	-
87	-	.015	-	-	-	-	-	-	-	-	-	-	.002
88	.002	-	-	-	-	-	.048	-	-	-	-	-	-
89	-	-	-	-	-	.066	-	.033	-	-	-	-	-
90	-	-	-	-	.072	-	-	-	.020	-	-	-	
91	-	-	-	.074	-	-	-	-	-	.013	-	-	-
92	-	-	.054	-	-	-	-	-	-	-	.009	-	-
93	-	.016	-	-	-	-	-	-	-	-	-	.005	-
94	.003	-	-	-	-	-	-	-	-	-	-	-	.003
95	-	-	-	-	-	.068	.049	-	-	-	-	-	-
96	-	-	-	-	.070	-	-	.034	-	-	-	-	-
97	-	-	-	.081	-	-	-	-	.020	-	-	-	-
98	-	-	.061	-	-	-	-	-	-	.015	-	-	-
99	-	.018	-	-	-	-	-	-	-	-	.009	-	-
100	.003	-	-	-	-	-	-	-	-	-	-	.007	-
101	-	-	-	-	-	.060	-	-	-	-	-	-	.004
102	-	-	-	-	.069	-	.050	-	-	-	-	-	-
103	-	-	-	.069	-	-	-	.035	-	-	-	-	-
104	-	-	.053	-	-	-	-	-	.024	-	-	-	-
105	-	.015	-	-	-	-	-	-	-	.018	-	-	-
106	.004	-	-	-	-	-	-	-	-	-	.009	-	-
107	-	-	-	-	-	.070	-	-	-	-	-	.007	-
108	-	-	-	-	.065	-	-	-	-	-	-	-	.008
109	-	-	-	.080	-	-	.050	-	-	-	-	-	-
110	-	-	.057	-	-	-	-	.039	-	-	-	-	-
111	-	.016	-	-	-	-	-	-	.026	-	-	-	-
112	.003	-	-	-	-	-	-	-	-	.019	-	-	-
113	-	-	-	-	-	.069	-	-	-	-	.013	-	-
114	-	-	-	-	.076	-	-	-	-	-	-	.009	-
115	-	-	-	.074	-	-	-	-	-	-	-	-	.005
116	-	-	.047	-	-	-	.057	-	-	-	-	-	-
117	-	.014	-	-	-	-	-	.042	-	-	-	-	-

TABLE IX-15 (cont'd)

Cycle No.	STATION NO. -20	0	25	50	80	100	130	170	200	225	250	275	300
118	.002	-	-	-	-	-	-	-	.025	-	-	-	-
119	-	-	-	-	-	.072	-	-	-	.020	-	-	-
120	-	-	-	-	.077	-	-	-	-	-	.014	-	-
121	-	-	-	.069	-	-	-	-	-	-	-	.009	-
122	-	-	.051	-	-	-	-	-	-	-	-	-	.007
123	-	.015	-	-	-	-	.057	-	-	-	-	-	-
124	.003	-	-	-	-	-	-	.042	-	-	-	-	-
125	-	-	-	-	-	.069	-	-	.027	-	-	-	-
126	-	-	-	-	.073	-	-	-	-	.021	-	-	-
127	-	-	-	.081	-	-	-	-	-	-	.015	-	-
128	-	-	.055	-	-	-	-	-	-	-	-	.010	-
129	-	.015	-	-	-	-	-	-	-	-	-	-	.007
130	.004	-	-	-	-	-	.057	-	-	-	-	-	-
131	-	-	-	-	-	.071	-	.039	-	-	-	-	-
132	-	-	-	-	.065	-	-	-	.030	-	-	-	-
133	-	-	-	.095	-	-	-	-	-	.023	-	-	-
134	-	-	.049	-	-	-	-	-	-	-	.009	-	-
135	-	.014	-	-	-	-	-	-	-	-	-	.008	-
136	.002	-	-	-	-	-	-	-	-	-	-	-	.004
137	-	-	-	-	-	.066	.053	-	-	-	-	-	-
138	-	-	-	-	.064	-	-	.043	-	-			
139	-	-	-	.085	-	-	-	-	.025	-	-	-	
140	-	-	.055	-	-	-	-	-	-	.020	-	-	-
141	-	.012	-	-	-	-	-	-	-	-	-	-	-
142	.004	-	-	-	-	-	-	-	-	-	-	.010	-
143	-	-	-	-	-	.066	-	-	-	-	-	-	.007
144	-	-	-	-	.061	-	.064	-	-	-	-	-	-
145	-	-	-	.077	-	-	-	.046	-	-	-	-	-
146	-	-	.064	-	-	-	-	-	.031	-	-	-	-
147	-	.018	-	-	-	-	-	-	-	.022	-	-	-
148	.003	-	-	-	-	-	-	-	-	-	.018	-	-
149	-	-	-	-	-	.059	-	-	-	-	-	.012	-
150	-	-	-	-	.068	-	-	-	-	-	-	-	.007
151	-	-	-	.074	-	-	.058	-	-	-	-	-	-
152	-	-	.061	-	-	-	-	.046	-	-	-	-	-
153	-	.014	-	-	-	-	-	-	.032	-	-	-	-
154	-	-	-	-	-	-	-	-	-	.023	-	-	-
155	-	-	-	-	-	.073	-	-	-	-	.013	-	-
156	.004	-	-	-	.071	-	-	-	-	-	-	.009	-
157	-	-	-	.058	-	-	-	-	-	-	-	-	.010
158	-	-	.055	-	-	-	.061	-	-	-	-	-	-
159	-	.015	-	-	-	-	-	.047	-	-	-	-	-
160	.003	-	-	-	-	-	-	-	.035	-	-	-	-
161	-	-	-	-	-	.077	-	-	-	.025	-	-	-
162	-	-	-	-	.077	-	-	-	-	-	.016	-	-
163	-	-	-	.077	-	-	-	-	-	-	-	.014	-
164	-	-	.053	-	-	-	-	-	-	-	-	-	.010
165	-	.016	-	-	-	-	.064	-	-	-	-	-	-
166	.002	-	-	-	-	-	-	.046	-	-	-	-	-
167	-	-	-	-	-	.074	-	-	.031	-	-	-	-
168	-	-	-	-	.070	-	-	-	-	.024	-	-	-
169	-	-	-	.081	-	-	-	-	-	-	.020	-	-
170	-	-	.056	-	-	-	-	-	-	-	-	.013	-
171	-	.010	-	-	-	-	-	-	-	-	-	-	.010
172	.002	-	-	-	-	-	.066	-	-	-	-	-	-

TABLE IX-15 (cont'd)

STATION NO.

Cycle No.	-20	0	25	50	80	100	130	170	200	225	250	275	300
173	-	-	-	-	-	.069	-	.048	-	-	-	-	-
174	-	-	-	-	.076	-	-	-	.035	-	-	-	-
175	-	-	-	.068	-	-	-	-	-	.032	-	-	-
176	-	-	.058	-	-	-	-	-	-	-	.022	-	-
177	-	-	-	-	-	-	-	-	-	-	-	.014	-
180	.003	.018	-	.084	.076	.073	.057	.037	.032	.026	.020	.014	.010

TABLE IX-16

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 8 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 7,000 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

STATION NO.

Cycle No.	25	50	80	100	130	170	200	225	250	275	300
0	-	-	.002	-							
1	-	-	.004	-							
2	-	.001	-	.002	-						
3	-	-	.012	-	-						
4	-	.002	-	.005	-						
5	-	-	-	-	.001						
6	-	-	.031	-	-						
7	-	.007	-	.013	-						
8	-	-	-	-	.003						
9	-	-	.042	-	-	-					
10	-	.009	-	.021	-	-					
11	.000	-	-	-	.007	-					
12	-	-	-	-	-	.000					
13	-	.012	.042	-	-	-					
14	.002	-	-	.033	-	-					
15	-	-	-	-	.012	-					
16	-	.009	-	-	-	.003					
17	.001	-	.051	-	-	-					
18	-	-	-	.041	-	-	-				
19	-	.014	-	-	.026	-	-				
20	.002	-	-	-	-	.008	-				
21	-	-	-	-	-	-	.003				
22	-	.015	.050	-	-	-	-				
23	.001	-	-	.047	-	-	-				
24	-	-	-	-	.033	-	-				
25	-	.014	-	-	-	.013	-				
26	.004	-	-	-	-	-	.004				
27	-	-	.057	-	-	-	-				
28	-	.015	-	.046	-	-	-				
29	.002	-	-	-	.038	-	-	-			
30	-	-	-	-	-	.015	-	-			
31	-	-	.060	-	-	-	.008	-			
32	-	.032	-	-	-	-	-	.005			
33	.004	-	-	.055	-	-	-	-			
34	-	-	-	-	.045	-	-	-			

TABLE IX-16 (cont'd)

Cycle No.	STATION NO. 25	50	80	100	130	170	200	225	250	275	300
35	-	-	.059	-	-	.023	-	-	-		
36	-	.016	-	-	-	-	.011	-	-		
37	.003	-	-	-	-	-	-	.008	-		
38	-	-	-	-	-	-	-	-	.005		
39	-	-	.072	.058	-	-	-	-	-		
40	-	.019	-	-	.048	-	-	-			
41	.004	-	-	-	-	.027	-	-	-		
42	-	-	-	-	-	-	.015	-	-	-	
43	-	-	-	.060	-	-	-	.010	-	-	
44	-	-	.073	-	-	-	-	-	.004	-	
45	-	.020	-	-	-	-	-	-	-	.004	
46	.003	-	-	-	-	-	-	-	-	-	
47	-	-	-	-	-	.028	-	-	-	-	
48	-	-	-	.067	.053	-	.015	-	-	-	
49	-	-	.070	-	-	-	-	.012	-	-	-
50	-	.020	-	-	-	-	-	-	.009	-	-
51	.007	-	-	-	-	-	-	-	-	.005	-
52	-	-	-	-	-	-	-	-	-	-	.002
53	-	-	-	.070	.060	-	-	-	-	-	-
54	-	-	-	-	-	.037	-	-	-	-	-
55	-	.024	-	-	-	-	.021	-	-	-	-
56	.005	-	-	-	-	-	-	.016	-	-	-
57	-	-	-	-	-	-	-	-	.009	-	-
58	-	-	-	-	-	-	-	-	-	.008	-
59	-	-	-	.067	-	-	-	-	-	-	.004
60	-	-	.078	-	.061	-	-	-	-	-	-
61	-	.022	-	-	-	.042	-	-	-	-	-
62	.005	-	-	-	-	-	.023	-	-	-	-
63	-	-	-	-	-	-	-	.019	-	-	-
64	-	-	-	-	-	-	-	-	.012	-	-
65	-	-	-	.072	-	-	-	-	-	.008	-
66	-	-	.073	-	-	-	-	-	-	-	.004
67	-	.021	-	-	.062	-	-	-	-	-	-
68	.004	-	-	-	-	.046	-	-	-	-	-
69	-	-	-	-	-	-	.027	-	-	-	-
70	-	-	-	-	-	-	-	.021	-	-	-
71	-	-	-	.068	-	-	-	-	.014	-	-
72	-	-	.077	-	-	-	-	-	-	.010	-
73	-	.021	-	-	-	-	-	-	-	-	.004
74	.003	-	-	-	.064	-	-	-	-	-	-
75	-	-	-	-	-	.046	-	-	-	-	-
76	-	-	-	-	-	-	.028	-	-	-	-
77	-	-	-	.067	-	-	-	.023	-	-	-
78	-	-	.068	-	-	-	-	-	.018	-	-
79	-	.024	-	-	-	-	-	-	-	.011	-
80	.004	-	-	-	-	-	-	-	-	-	.007
81	-	-	-	-	.066	-	-	-	-	-	-
82	-	-	-	-	-	.048	-	-	-	-	-
83	-	-	-	.067	-	-	.036	-	-	-	-
84	-	-	.076	-	-	-	-	.028	-	-	-
85		.023	-	-	-	-	-	-	.020	-	-
86	.004	-	-	-	-	-	-	-	-	.013	-
87	-	-	-	-	-	-	-	-	-	-	.009
88	-	-	-	-	.066	-	-	-			
89	-	-	-	.076	-	.050	-	-	-		

TABLE IX-16 (cont'd)

Cycle	STATION NO.										
No.	25	50	80	100	130	170	200	225	250	275	300
90	-	-	.078	-	-	-	.037	-	-	-	
91	-	.027	-	-	-	-	-	.032	-	-	-
92	.008	-	-	-	-	-	-	-	.020	-	-
93	-	-	-	-	-	-	-	-	-	.015	-
94	-	-	-	-	-	-	-	-	-	-	.008
95	-	-	-	.077	.069	-	-	-	-	-	-
96	-	-	.080	-	-	.054	-	-	-	-	-
97	-	.025	-	-	-	-	.042	-	-	-	-
98	.007	-	-	-	-	-	-	.032	-	-	-
99	-	-	-	-	-	-	-	-	.021	-	-
100	-	-	-	-	-	-	-	-	-	.014	-
101	-	-	-	.077	-	-	-	-	-	-	.009
102	-	-	.073	-	.070	-	-	-	-	-	-
103	-	.025	-	-	-	.057	-	-	-	-	-
104	.007	-	-	-	-	-	.039	-	-	-	-
105	-	-	-	-	-	-	-	.032	-	-	-
106	-	-	-	-	-	-	-	-	.023	-	-
107	-	-	-	.077	-	-	-	-	-	.015	-
108	-	-	.081	-	-	-	-	-	-	-	.011
109	-	.027	-	-	.072	-	-	-	-	-	-
110	.008	-	-	-	-	.061	-	-	-	-	-
111	-	-	-	-	-	-	.045	-	-	-	-
112	-	-	-	-	-	-	-	.036	-	-	-
113	-	-	-	.072	-	-	-	-	.025	-	-
114	-	-	.073	-	-	-	-	-	-	.016	-
115	-	.022	-	-	-	-	-	-	-	-	.012
116	.007	-	-	-	.073	-	-	-	-	-	-
117	-	-	-	-	-	.062	-	-	-	-	-
118	-	-	-	-	-	-	.042	-	-	-	-
119	-	-	-	.073	-	-	-	.039	-	-	-
120	-	-	.081	-	-	-	-	-	.026	-	-
121	-	.020	-	-	-	-	-	-	-	.021	-
122	.004	-	-	-	-	-	-	-	-	-	.013
123	-	-	-	-	.065	-	-	-	-	-	-
124	-	-	-	-	-	.059	-	-	-	-	-
125	-	-	-	.077	-	-	.047	-	-	-	-
126	-	-	.079	-	-	-	-	.037	-	-	-
127	-	.025	-	-	-	-	-	-	.028	-	-
128	.008	-	-	-	-	-	-	-	-	.023	-
129	-	-	-	-	-	-	-	-	-	-	.012
130	-	-	-	-	.076	-	-	-	-	-	-
131	-	-	-	.078	-	.060	-	-	-	-	-
132	-	-	.080	-	-	-	.047	-	-	-	-
133	-	.023	-	-	-	-	-	.038	-	-	-
134	.004	-	-	-	-	-	-	-	.023	-	-
135	-	-	-	-	-	-	-	-	-	.015	-
136	-	-	-	-	-	-	-	-	-	-	.012
137	-	-	-	.066	.073	-	-	-	-	-	-
138	-	-	.069	-	-	.061	-	-	-	-	-
139	-	.024	-	-	-	-	.044	-	-	-	-
140	.008	-	-	-	-	-	-	.037	-	-	-
141	-	-	-	-	-	-	-	-	.031	-	-
142	-	-	-	-	-	-	-	-	-	.020	-
143	-	-	-	.078	-	-	-	-	-	-	.015
144	-	-	.085	-	.079	-	-	-	-	-	-

TABLE IX-16 (cont'd)

Cycle No.	STATION NO. 25	50	80	100	130	170	200	225	250	275	300
145	-	.028	-	-	-	.059	-	-	-	-	-
146	.007	-	-	-	-	-	.049	-	-	-	-
147	-	-	-	-	-	-	-	.042	-	-	-
148	-	-	-	-	-	-	-	-	.031	-	-
149	-	-	-	.066	-	-	-	-	-	.024	-
150	-	-	.094	-	-	-	-	-	-	-	.014
151	-	.028	-	-	.076	-	-	-	-	-	-
152	.004	-	-	-	-	.060	-	-	-	-	-
153	-	-	-	-	-	-	.042	-	-	-	-
154	-	-	-	-	-	-	-	.044	-	-	-
155	-	-	-	.077	-	-	-	-	.031	-	-
156	-	-	.077	-	-	-	-	-	-	.024	-
157	-	.041	-	-	-	-	-	-	-	-	.016
158	.005	-	-	-	.078	-	-	-	-	-	-
159	-	-	-	-	-	.065	-	-	-	-	-
160	-	-	-	-	-	-	.054	-	-	-	-
161	-	-	-	.081	-	-	-	.046	-	-	-
162	-	-	.078	-	-	-	-	-	.033	-	-
163	-	.025	-	-	-	-	-	-	-	.023	-
164	.005	-	-	-	-	-	-	-	-	-	.016
165	-	-	-	-	.073	-	-	-	-	-	-
166	-	-	-	-	-	.056	-	-	-	-	-
167	-	-	-	.080	-	-	.049	-	-	-	-
168	-	-	.069	-	-	-	-	.042	-	-	-
169	-	.022	-	-	-	-	-	-	.034	-	-
170	.005	-	-	-	-	-	-	-	-	.027	-
171	-	-	-	-	-	-	-	-	-	-	.018
172	-	-	-	-	.074	-	-	-	-	-	-
173	-	-	-	.077	-	.069	-	-	-	-	-
174	-	-	.077	-	-	-	.056	-	-	-	-
175	-	.025	-	-	-	-	-	.050	-	-	-
176	.006	-	-	-	-	-	-	-	.037	-	-
177	-	-	-	-	-	-	-	-	-	.030	-
180	-	.026	.069	.073	.066	.049	.053	.046	.037	.027	.018

TABLE IX-17

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 9 H.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 8,000 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
1	-	.001	-									
2	-	-	.004									
3	-	.005	-	-	-							
4	-	-	.010	-	-							
5	-	.010	-	-	-							
6	-	-	.018	.000	.000							
7	-	.015	-	-	-							

TABLE IX-17 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
8	-	-	.025	-	-							
9	-	.023	-	.004	-							
10	-	-	.035	-	.003							
11	-	.021	-	-	-							
12	-	-	.032	.012								
13	-	.022	-	-	-	-						
14	-	-	.035	-	.008	-						
15	-	.023	-	.020	-	-						
16	.004	-	-	-	-	.000						
17	-	-	.037	-	.011	-						
18	-	.025	-	.024	-	-						
19	.004	-	-	-	-	-						
20	-	-	.044	-	-	.003	-					
21	-	.032	-	-	.020	-	-					
22	.005	-	-	.033	-	-	-					
23	-	-	.041	-	-	-	.003					
24	-	.037	-	-	-	.009	-					
25	.007	-	-	-	.024	-	-					
26	-	-	.051	.035	-	-	-					
27	-	.037	-	-	-	-	-					
28	.005	-	-	-	-	-	.004					
29	-	-	.056	-	-	.013	-	-				
30	-	.036	-	-	.032	-	-	-				
31	.007	-	-	-	-	-	-	-				
32	-	-	-	.047	-	-	-	.002				
33	-	-	.056	-	-	-	.005	-	-			
34	-	.039	-	-	-	.021	-	-	-			
35	.007	-	-	-	.039	-	-	-	-			
36	-	-	-	.046	-	-	-	-	.003			
37	-	-	.061	-	-	-	-	.003	-			
38	-	.038	-	-	-	-	-	-	-			
39	.008	-	-	-	-	.024	.010	-	-			
40	-	-	-	.049	.046	-	-	-	-			
41	-	-	.064	-	-	-	-	-	-			
42	-	.035	-	-	-	-	-	-	.003			
43	.010	-	-	-	-	-	-	.005	-	-		
44	-	-	-	-	.046	-	.012	-	-	-		
45	-	-	-	.047	-	.030	-	-	-	-		
46	-	-	.059	-	-	-	-	-	-	.003		
47	-	.043	-	-	-	-	-	-	.004	-		
48	.005	-	-	-	-	-	-	.009	-	-	-	
49	-	-	-	-	.051	-	.018	-	-	-	-	
50	-	-	-	.053	-	.030	-	-	-	-	-	
51	-	-	.066	-	-	-	-	-	-	-	.002	
52	-	.036	-	-	-	-	-	-	-	.003	-	
53	.011	-	-	-	-	-	-	-	.005	-	-	-
54	-	-	-	-	-	.037	-	.009	-	-	-	-
55	-	-	-	-	.046	-	.020	-	-	-	-	-
56	-	-	-	.056	-	-	-	-	-	-	-	.003
57	-	-	.059	-	-	-	-	-	-	-	.002	-
58	-	.046	-	-	-	-	-	-	-	.004	-	-
59	.009	-	-	-	-	-	-	-	.007	-	-	-
60	-	-	-	-	-	.041	-	.012	-	-	-	-
61	-	-	-	-	.054	-	.025	-	-	-	-	-
62	-	-	-	.060	-	-	-	-	-	-	-	.002

TABLE IX-17 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
63	-	-	.077	-	-	-	-	-	-	-	.003	-
64	-	.038	-	-	-	-	-	-	-	.004	-	-
65	.012	-	-	-	-	-	-	-	.008	-	-	-
66	-	-	-	-	-	.044	-	.015	-	-	-	-
67	-	-	-	-	.055	-	.027	-	-	-	-	-
68	-	-	-	.054	-	-	-	-	-	-	-	.002
69	-	-	.057	-	-	-	-	-	-	-	.003	-
70	-	.039	-	-	-	-	-	-	-	.005	-	-
71	.010	-	-	-	-	-	-	-	.008	-	-	-
72	-	-	-	-	-	.043	-	.014	-	-	-	-
73	-	-	-	-	.058	-	.027	-	-	-	-	-
74	-	-	-	.051	-	-	-	-	-	-	-	.002
75	-	-	.066	-	-	-	-	-	-	-	.004	-
76	-	.030	-	-	-	-	-	-	-	.007	-	-
77	.008	-	-	-	-	-	-	-	.010	-	-	-
78	-	-	-	-	-	.042	-	.018	-	-	-	-
79	-	-	-	-	.059	-	.030	-	-	-	-	-
80	-	-	-	.057	-	-	-	-	-	-	-	.002
81	-	-	.065	-	-	-	-	-	-	-	.005	-
82	-	.038	-	-	-	-	-	-	-	.008	-	-
83	.009	-	-	-	-	-	-	-	.010	-	-	-
84	-	-	-	-	-	.044	-	.019	-	-	-	-
85	-	-	-	-	.061	-	.031	-	-	-	-	-
86	-	-	-	.050	-	-	-	-	-	-	-	.003
87	-	-	.065	-	-	-	-	-	-	-	.004	-
88	-	.043	-	-	-	-	-	-	-	.009	-	-
89	.010	-	-	-	-	-	-	-	.012	-	-	-
90	-	-	-	-	-	.044	-	.018	-	-	-	-
91	-	-	-	-	.058	-	.031	-	-	-	-	-
92	-	-	-	.056	-	-	-	-	-	-	-	.004
93	-	-	.071	-	-	-	-	-	-	-	.007	-
94	-	.034	-	-	-	-	-	-	-	.009	-	-
95	.007	-	-	-	-	-	-	-	.013	-	-	-
96	-	-	-	-	-	.046	-	.022	-	-	-	-
97	-	-	-	-	.060	-	.032	-	-	-	-	-
98	-	-	-	.054	-	-	-	-	-	-	-	.003
99	-	-	.062	-	-	-	-	-	-	-	.007	-
100	-	.042	-	-	-	-	-	-	-	.010	-	-
101	.009	-	-	-	-	-	-	-	.014	-	-	-
102	-	-	-	-	-	.049	-	.022	-	-	-	-
103	-	-	-	-	.058	-	.034	-	-	-	-	-
104	-	-	-	.057	-	-	-	-	-	-	-	.004
105	-	-	.058	-	-	-	-	-	-	-	.005	-
106	-	-	-	-	-	-	-	-	-	.012	-	-
107	.009	-	-	-	-	-	-	-	.016	-	-	-
108	-	-	-	-	-	.046	-	.024	-	-	-	-
109	-	-	-	-	.056	-	.034	-	-	-	-	-
110	-	-	-	.058	-	-	-	-	-	-	-	.005
111	-	-	.058	-	-	-	-	-	-	-	.007	-
112	-	.042	-	-	-	-	-	-	-	.011	-	-
113	.010	-	-	-	-	-	-	-	.016	-	-	-
114	-	-	-	-	-	.050	-	.025	-	-	-	-
115	-	-	-	-	.065	-	.038	-	-	-	-	-
116	-	-	-	.064	-	-	-	-	-	-	-	.005
117	-	-	.069	-	-	-	-	-	-	-	.008	-

TABLE IX-17 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
118	-	.042	-	-	-	-	-	-	-	.012	-	-
119	.012	-	-	-	-	-	-	-	.018	-	-	-
120	-	-	-	-	-	.056	-	.023	-	-	-	-
121	-	-	-	-	.061	-	.039	-	-	-	-	-
122	-	-	-	.066	-	-	-	-	-	-	-	.007
123	-	-	.066	-	-	-	-	-	-	-	.008	-
124	-	.043	-	-	-	-	-	-	-	.013	-	-
125	.009	-	-	-	-	-	-	-	.016	-	-	-
126	-	-	-	-	-	.049	-	.027	-	-	-	-
127	-	-	-	-	.062	-	.042	-	-	-	-	-
128	-	-	-	.058	-	-	-	-	-	-	-	.005
129	-	-	.070	-	-	-	-	-	-	-	.010	-
130	-	.046	-	-	-	-	-	-	-	.013	-	-
131	.009	-	-	-	-	-	-	-	.020	-	-	-
132	-	-	-	-	-	.051	-	.024	-	-	-	-
133	-	-	-	-	.057	-	.043	-	-	-	-	-
134	-	-	-	.060	-	-	-	-	-	-	-	.008
135	-	-	.055	-	-	-	-	-	-	-	.010	-
136	-	.046	-	-	-	-	-	-	-	.013	-	-
137	.012	-	-	-	-	-	-	-	.019	-	-	-
138	-	-	-	-	-	.050	-	.030	-	-	-	-
139	-	-	-	-	.065	-	.042	-	-	-	-	-
140	-	-	-	.047	-	-	-	-	-	-	-	.008
141	-	-	.067	-	-	-	-	-	-	-	.009	-
142	-	.043	-	-	-	-	-	-	-	.013	-	-
143	.008	-	-	-	-	-	-	-	.021	-	-	-
144	-	-	-	-	-	.054	-	.030	-	-	-	-
145	-	-	-	-	.059	-	.044	-	-	-	-	-
146	-	-	-	.071	-	-	-	-	-	-	-	.007
147	-	-	.066	-	-	-	-	-	-	-	.011	-
148	-	.047	-	-	-	-	-	-	-	.014	-	-
149	.008	-	-	-	-	-	-	-	.021	-	-	-
150	-	-	-	-	-	.055	-	.028	-	-	-	-
151	-	-	-	-	.065	-	.042	-	-	-	-	-
152	-	-	-	.067	-	-	-	-	-	-	-	.007
153	-	-	.068	-	-	-	-	-	-	-	.011	-
154	-	.046	-	-	-	-	-	-	-	.019	-	-
155	.011	-	-	-	-	-	-	-	.022	-	-	-
156	-	-	-	-	-	.058	-	.030	-	-	-	-
157	-	-	-	-	.061	-	.046	-	-	-	-	-
158	-	-	-	.061	-	-	-	-	-	-	-	.007
159	-	-	.069	-	-	-	-	-	-	-	.011	-
160	-	.048	-	-	-	-	-	-	-	.015	-	-
161	.010	-	-	-	-	-	-	-	.021	-	-	-
162	-	-	-	-	-	.054	-	.032	-	-	-	-
163	-	-	-	-	.061	-	.045	-	-	-	-	-
164	-	-	-	.065	-	-	-	-	-	-	-	.009
165	-	-	.058	-	-	-	-	-	-	-	.012	-
166	-	.041	-	-	-	-	-	-	-	.020	-	-
167	.008	-	-	-	-	-	-	-	.020	-	-	-
168	-	-	-	-	-	.055	-	.031	-	-	-	-
169	-	-	-	-	.061	-	.031	-	-	-	-	-
170	-	-	-	.066	-	-	-	-	-	-	-	.007
171	-	-	.066	-	-	-	-	-	-	-	.011	-
172	-	.036	-	-	-	-	-	-	-	.018	-	-

TABLE IX-17 (cont'd)

Cycle No.	STATION NO. 0	25	50	80	100	130	170	200	225	250	275	300
173	.009	-	-	-	-	-	-	-	.023	-	-	-
174	-	-	-	-	-	.060	-	.033	-	-	-	-
175	-	-	-	-	.060	-	.043	-	-	-	-	-
176	-	-	-	.069	-	-	-	-	-	-	-	.007
177	-	-	.070	-	-	-	-	-	-	-	.012	-
180	.011	-	.064	.065	.058	.032	.044	.028	.026	.014	.012	.005

TABLE IX-18

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 9 L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 8,000 cfs at Trenton, New Jersey
(b) Release Point Station +50
(c) Dye Release Continuous at 100 ml/cycle
(d) Initial Dye Concentration 913 ppm

Cycle No.	STATION NO. 25	50	80	100	130	170	200	225	250	275	300
0	-	-	.002	-							
1	.000	-	.006	.001	-						
2	-	.001	-	.002	-						
3	.001	-	.014	-	-						
4	-	.002	-	.007	.000						
5	.000	-	-	-	-						
6	-	.001	.023	.016	-						
7	.000	-	-	-	.001						
8	-	.002	-	-	-						
9	.000	-	.039	-	-						
10	-	.003	-	.022	.005						
11	.000	-	-	-	-						
12	-	.004	.042	-	-						
13	.000	-	-	-	.010						
14	-	.008	-	.031	-						
15	.000	-	.049	-	-						
16	-	-	-	-	.021	-					
17	-	.010	-	.038	-	-					
18	.000	-	.057	-	-	-					
19	-	-	-	-	-	.005					
20	-	.009	-	-	.026	-					
21	.001	-	-	.039	-	-					
22	-	-	.050	-	-	-					
23	-	.010	-	-	-	.008					
24	.000	-	-	-	.034	-	-				
25	-	-	-	.048	-	-	-				
26	-	.010	.055	-	-	-	-				
27	.001	-	-	-	-	-	.004				
28	-	-	-	-	-	.019	-	-			
29	-	.012	-	-	.041	-	-	-			
30	.001	-	-	.049	-	-	-	-			
31	-	-	-	-	-	-	-	.004			
32	-	-	.060	-	-	-	.008	-			
33	-	.016	-	-	-	.020	-	-			
34	.001	-	-	-	.046	-	-	-			

TABLE IX-18 (cont'd)

STATION NO.

Cycle No.	25	50	80	100	130	170	200	225	250	275	300
35	-	-	-	.054	-	-	-	-			
36	-	-	.057	-	-	-	-	.007			
37	-	.013	-	-	-	-	.012	-			
38	.001	-	-	-	-	.026	-	-			
39	-	-	-	-	.050	-	-	-			
40	-	-	.066	.056	-	-	-	-			
41	-	.018	-	-	-	-	-	-	.005		
42	.011	-	-	-	-	-	-	.009	-		
43	-	-	-	-	-	-	.015	-	-	-	
44	-	-	-	.059	-	.036	-	-	-	-	
45	-	-	.061	-	.051	-	-	-	-	-	
46	-	.018	-	-	-	-	-	-	.008	.004	
47	.002	-	-	-	-	-	-	.012	-	-	
48	-	-	-	-	-	-	.021	-	-	-	-
49	-	-	-	.057	-	.035	-	-	-	-	-
50	-	-	.066	-	.056	-	-	-	-	-	-
51	-	.018	-	-	-	-	-	-	-	.007	.002
52	.002	-	-	-	-	-	-	-	.008	-	-
53	-	-	-	-	-	-	-	.016	-	-	-
54	-	-	-	-	.059	-	.023	-	-	-	-
55	-	-	-	.049	-	.036	-	-	-	-	-
56	-	-	.068	-	-	-	-	-	-	-	.002
57	-	.015	-	-	-	-	-	-	-	.009	-
58	.003	-	-	-	-	-	-	-	.011	-	-
59	-	-	-	-	-	-	-	.020	-	-	-
60	-	-	-	-	.056	-	.027	-	-	-	-
61	-	-	-	.061	-	.043	-	-	-	-	-
62	-	-	.060	-	-	-	-	-	-	-	.005
63	-	.015	-	-	-	-	-	-	-	.009	-
64	.004	-	-	-	-	-	-	-	.012	-	-
65	-	-	-	-	-	-	-	.022	-	-	-
66	-	-	-	-	.057	-	.027	-	-	-	-
67	-	-	-	.059	-	.046	-	-	-	-	-
68	-	-	.055	-	-	-	-	-	-	-	.004
69	-	.014	-	-	-	-	-	-	-	.009	-
70	.002	-	-	-	-	-	-	-	.012	-	-
71	-	-	-	-	-	-	-	.024	-	-	-
72	-	-	-	-	.061	-	.031	-	-	-	-
73	-	-	-	.059	-	.049	-	-	-	-	-
74	-	-	.054	-	-	-	-	-	-	-	.005
75	-	.018	-	-	-	-	-	-	-	.011	-
76	.001	-	-	-	-	-	-	-	.015	-	-
77	-	-	-	-	-	-	-	.023	-	-	-
78	-	-	-	-	.061	-	.036	-	-	-	-
79	-	-	-	.060	-	.049	-	-	-	-	-
80	-	-	.060	-	-	-	-	-	-	-	.005
81	-	.014	-	-	-	-	-	-	-	.010	-
82	.003	-	-	-	-	-	-	-	.018	-	-
83	-	-	-	-	-	-	-	.032	-	-	-
84	-	-	-	-	.055	-	.034	-	-	-	-
85	-	-	-	.061	-	.048	-	-	-	-	-
86	-	-	.057	-	-	-	-	-	-	-	.007
87	-	.020	-	-	-	-	-	-	-	.013	-
88	.001	-	-	-	-	-	-	-	.021	-	-
89	-	-	-	-	-	-	-	.027	-	-	-

TABLE IX-18 (cont'd)

Cycle No.	STATION NO. 25	50	80	100	130	170	200	225	250	275	300
90	-	-	-	-	.060	-	.035	-	-	-	-
91	-	-	-	.066	-	.048	-	-	-	-	-
92	-	-	.069	-	-	-	-	-	-	-	.010
93	-	.016	-	-	-	-	-	-	-	.014	-
94	.002	-	-	-	-	-	-	-	.018	-	-
95	-	-	-	-	-	-	-	.031	-	-	-
96	-	-	-	-	.059	-	.038	-	-	-	-
97	-	-	-	.066	-	.046	-	-	-	-	-
98	-	-	.059	-	-	-	-	-	-	-	.010
99	-	.012	-	-	-	-	-	-	-	.016	-
100	.003	-	-	-	-	-	-	-	.023	-	-
101	-	-	-	-	-	-	-	.033	-	-	-
102	-	-	-	-	.057	-	.037	-	-	-	-
103	-	-	-	.064	-	.053	-	-	-	-	-
104	-	-	.059	-	-	-	-	-	-	-	.009
105	-	.016	-	-	-	-	-	-	-	.016	-
106	.003	-	-	-	-	-	-	-	.026	-	-
107	-	-	-	-	-	-	-	.035	-	-	-
108	-	-	-	-	.061	-	.035	-	-	-	-
109	-	-	-	.068	-	.050	-	-	-	-	-
110	-	-	.059	-	-	-	-	-	-	-	.009
111	-	.018	-	-	-	-	-	-	-	.018	-
112	.003	-	-	-	-	-	-	-	.025	-	-
113	-	-	-	-	-	-	-	.038	-	-	-
114	-	-	-	-	.061	-	.038	-	-	-	-
115	-	-	-	.065	-	.057	-	-	-	-	-
116	-	-	.072	-	-	-	-	-	-	-	.009
117	-	.018	-	-	-	-	-	-	-	.019	-
118	.004	-	-	-	-	-	-	-	.026	-	-
119	-	-	-	-	-	-	-	.038	-	-	-
120	-	-	-	-	.062	-	.039	-	-	-	-
121	-	-	-	.065	-	.057	-	-	-	-	-
122	-	-	.070	-	-	-	-	-	-	-	.011
123	-	.018	-	-	-	-	-	-	-	.020	-
124	.004	-	-	-	-	-	-	-	.024	-	-
125	-	-	-	-	-	-	-	.038	-	-	-
126	-	-	-	-	.065	-	.039	-	-	-	-
127	-	-	-	.069	-	.058	-	-	-	-	-
128	-	-	.072	-	-	-	-	-	-	-	.010
129	-	.018	-	-	-	-	-	-	-	.020	-
130	.000	-	-	-	-	-	-	-	.031	-	-
131	-	-	-	-	-	-	-	.035	-	-	-
132	-	-	-	-	.065	-	.046	-	-	-	-
133	-	-	-	.069	-	.055	-	-	-	-	-
134	-	-	.059	-	-	-	-	-	-	-	.010
135	-	.018	-	-	-	-	-	-	-	.020	-
136	.003	-	-	-	-	-	-	-	.028	-	-
137	-	-	-	-	-	-	-	.037	-	-	-
138	-	-	-	-	.065	-	.043	-	-	-	-
139	-	-	-	.069	-	.058	-	-	-	-	-
140	-	-	.077	-	-	-	-	-	-	-	.012
141	-	.018	-	-	-	-	-	-	-	.021	-
142	.001	-	-	-	-	-	-	-	.028	-	-
143	-	-	-	-	-	-	-	.037	-	-	-
144	-	-	-	-	.069	-	.047	-	-	-	-

TABLE IX-18 (cont'd)

Cycle No.	STATION NO. 25	50	80	100	130	170	200	225	250	275	300
145	-	-	-	.068	-	.064	-	-	-	-	-
146	-	-	.070	-	-	-	-	-	-	-	.012
147	-	.015	-	-	-	-	-	-	-	.022	-
148	.002	-	-	-	-	-	-	-	.028	-	-
149	-	-	-	-	-	-	-	.039	-	-	-
150	-	-	-	-	.068	-	.048	-	-	-	-
151	-	-	-	.067	-	.058	-	-	-	-	-
152	-	-	.079	-	-	-	-	-	-	-	.013
153	-	.015	-	-	-	-	-	-	-	.022	-
154	.003	-	-	-	-	-	-	-	.033	-	-
155	-	-	-	-	-	-	-	.039	-	-	-
156	-	-	-	-	.062	-	.048	-	-	-	-
157	-	-	-	.069	-	.058	-	-	-	-	-
158	-	-	.077	-	-	-	-	-	-	-	.015
159	-	.018	-	-	-	-	-	-	-	.023	-
160	.003	-	-	-	-	-	-	-	.031	-	-
161	-	-	-	-	-	-	-	.042	-	-	-
162	-	-	-	-	.069	-	.046	-	-	-	-
163	-	-	-	.061	-	.058	-	-	-	-	-
164	-	-	.070	-	-	-	-	-	-	-	.014
165	-	.020	-	-	-	-	-	-	-	.023	-
166	.003	-	-	-	-	-	-	-	-	-	-
167	-	-	-	-	-	-	-	.038	-	-	-
168	-	-	-	-	.062	-	.050	-	-	-	-
169	-	-	-	.055	-	.049	-	-	-	-	-
170	-	-	.068	-	-	-	-	-	-	-	.014
171	-	.013	-	-	-	-	-	-	-	.024	-
172	.003	-	-	-	-	-	-	-	.032	-	-
173	-	-	-	-	-	-	-	.042	-	-	-
174	-	-	-	-	.065	-	.045	-	-	-	-
175	-	-	-	.070	-	.058	-	-	-	-	-
176	-	-	.070	-	-	-	-	-	-	-	.012
177	-	.018	-	-	-	-	-	-	-	.023	-
180	-	.034	.071	.066	.065	.050	.044	.041	.031	.024	.013

TABLE IX-19

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 10 H. & L. W. S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3, 400 cfs at Trenton, New Jersey
(b) Release Point Station 0+00
(c) Instantaneous Dye Release
(d) Initial Dye Concentration 2, 605 cc at 913 ppm

STATION	Cycle 3		Cycle 5		Cycle 10		Cycle 15	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-40	.001	-	.004	-	.005	-	.043	-
-30	.019	.000	.024	.001	-	-	-	-
-20	.080	.001	.084	.001	.009	.000	.033	.001
-10	.164	.001	.118	.002	-	-	-	-
0	.198	.001	.152	.003	.084	.005	.046	.003
10	.164	.024	.137	.034	-	-	-	-
20	.114	.071	.097	-	.081	.044	.038	.027
30	.033	.136	.072	.101	-	-	-	-
40	-	-	-	-	.049	.076	.043	.053
50	.002	.152	.011	.141	-	-	-	-
60	.000	.106	.002	.089	.015	.074	.027	.055
70	.000	.034	-	-	-	-	-	-
80	-	.005	.002	.004	.002	.046	.008	.047
100	-	-	.000	.003	.001	.021	.002	.031
120	-	-	-	.002	.000	.008	.000	.015
140	-	-	-	-	-	.002	.000	.004
160	-	-	-	-	-	-	-	.002

	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-40	.003	-	.003	-	.004	-	.001	-
-20	.024	.000	.015	.001	.010	.001	.008	.000
0	.038	.004	.023	.008	.020	.000	.013	.001
20	.049	.023	.038	.011	.026	.009	.021	.008
40	.050	.028	.039	.027	.032	.018	.022	.012
60	.033	.039	.035	.034	.027	.025	.021	.019
80	.015	.031	.018	.038	.021	.027	.021	.026
100	.009	.033	.014	.026	.012	.028	.016	.023
120	.003	.023	.005	.023	.007	.020	.008	.021
140	.002	.008	.002	.011	.004	.015	.004	.012
160	-	.004	.002	.005	.003	.008	.002	.008
180	-	.002	-	.003	.004	.004	.002	.004
200	-	-	-	.005	-	.002	-	.002

TABLE IX-19 (cont'd)

STATION	Cycle 40		Cycle 45		Cycle 50		Cycle 55	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-40	.002	-	.001	-	.000	-	.000	-
-20	.007	.001	.004	.000	.004	.000	.003	.000
0	.011	.002	.007	.000	.005	.000	.004	.000
20	.016	.004	.012	.005	.009	.001	.003	.002
40	.021	.009	.015	.007	.010	.005	.009	.004
60	.022	.012	.019	.010	.015	.009	.012	.004
80	.015	.018	.016	.012	.014	.012	.012	.009
100	.014	.020	.012	.014	.013	.013	.011	.010
120	.008	.019	.009	.019	.009	.014	.008	.012
140	.004	.013	.007	.014	.005	.013	.005	.013
160	.005	.008	.004	.011	.002	.009	.002	.008
180	.003	.005	.003	.007	.003	.007	.003	.008
200	.000	.003	.002	.004	.002	.004	.002	.007
225	-	.003	-	.003	-	.002	.002	.004
250	-	-	-	-	-	-	-	.002

	Cycle 60		Cycle 65		Cycle 70		Cycle 75	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-20	.002	.001	.002	.000	.002	.000	.000	-
0	.003	.001	.003	.001	.003	.000	.001	.000
20	.004	.003	.004	.002	.004	.001	.001	.001
40	.007	.003	.007	.004	.004	.001	.004	.002
60	.009	.005	.008	.004	.007	.004	.005	.004
80	.011	.008	.009	.007	.008	.007	.009	.004
100	.010	.010	.009	.008	.009	.008	.008	.005
120	.008	.010	.008	.008	.008	.008	.005	.005
140	.005	.009	.004	.008	.005	.008	.004	.008
160	.004	.008	.004	.008	.004	.007	.005	.007
180	.002	.005	.004	.005	.003	.005	.004	.005
200	.002	.005	.002	.007	.002	.004	.004	.003
225	.002	.004	.002	.003	.002	.004	.002	.003
250	-	.002	-	.002	-	.003	-	.002
275	-	-	-	-	-	-	-	.002

TABLE IX-19 (cont'd)

STATION	Cycle 80		Cycle 85		Cycle 90		Cycle 95	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-20	.002	-	-	-	-	-	-	-
0	.002	.000	.001	.000	.001	.000	.001	.000
20	.003	.000	.001	.002	.001	.000	.001	.000
40	.003	.001	.003	.002	.003	.002	.001	.001
60	.005	.001	.004	.003	.004	.002	.004	.002
80	.000	.003	.004	.002	.005	.003	.004	.003
100	.008	.004	.007	.004	.005	.003	.005	.003
120	.005	.005	.005	.004	.007	.004	.007	.004
140	.005	.005	.005	.005	.005	.004	.004	.004
160	.004	.005	.003	.007	.004	.004	.003	.005
180	.003	.004	.003	.004	.003	.003	.003	.004
200	.003	.005	.002	.003	.003	.005	.002	.004
225	.003	.004	.002	.004	.002	.007	.002	.003
250	-	.000	.002	.002	.002	.004	.002	.003
275	-	.002	-	.002	-	.002	-	.002
300	-	-	-	-	-	-	-	.001

	Cycle 100	
	H.W.S.	L.W.S.
0	.001	.000
20	.002	.000
40	.003	.002
60	.002	.002
70	.002	-
80	.004	.003
90	.004	-
100	.005	.002
110	.005	-
120	.004	.003
130	.003	.004
140	.004	.004
150	-	.004
160	.003	.005
170	-	.003
180	.004	.004
190	-	.003
200	.004	.004
225	.003	.004
250	.001	.003
275	-	.001
300	-	.001

TABLE IX-20

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 11 H. & L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 7,000 cfs at Trenton, New Jersey
(b) Release Point Station 0+00
(c) Instantaneous Dye Release
(d) Initial Dye Concentration 2,605 cc at 913 ppm

STATION	Cycle 3		Cycle 5		Cycle 10		Cycle 15	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-40	.000	-	.007	-	.000	-	-	-
-30	.010	-	.022	-	.009	-	.004	-
-20	.002	.008	.053	-	.025	-	-	-
-15	-	-	-	-	-	-	.018	-
-10	.004	.008	.095	.003	.048	-	-	-
0	.001	.010	.108	.003	.069	.002	.037	.002
10	.001	.031	.155	.024	.087	.010	.048	-
20	.157	.060	.142	.043	.087	.018	.048	.011
30	.127	.110	.123	.084	.085	.042	.055	-
40	.027	.160	.062	.115	.092	.055	.060	.028
50	.009	.202	.037	.134	.071	.056	.066	-
60	.001	.084	.015	.122	.049	.082	.060	.046
70	.001	.072	.004	.112	.037	.076	.061	.050
80	-	.025	.005	.079	.025	.079	.047	.058
90	-	.012	.003	.045	.010	.072	.026	.066
100	-	-	-	.018	.003	.054	.018	.051
110	-	-	-	.005	.003	.048	-	-
120	-	-	-	.008	.002	.036	.005	.053
130	-	-	-	-	-	.014	-	-
140	-	-	-	-	-	.009	.002	.027
150	-	-	-	-	-	.004	-	-
160	-	-	-	-	-	.002	-	.010
170	-	-	-	-	-	.001	-	-
180	-	-	-	-	-	-	-	.003

STATION	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-30	.004	-	.002	-	-	-	-	-
-15	.012	-	.005	-	-	-	-	-
-10	-	-	-	-	.003	-	.002	-
0	.019	.000	.009	.002	-	-	.004	-
10	-	-	-	-	.005	-	-	-
20	.022	.007	.020	.002	.011	.001	.008	.001
40	.039	.015	.028	.008	.012	.005	.010	.004
50	.047	-	.035	-	.020	-	-	-
60	.043	.028	.041	.019	-	-	.020	.003
70	.051	-	.045	-	-	-	-	-
80	.041	.039	.047	.030	.027	.020	.021	.011
90	.038	.037	.045	.032	-	-	-	-
100	.031	.049	.041	.037	.035	.023	.032	.015
110	.021	.048	.032	.041	-	-	-	-
120	.018	.041	.026	.039	.025	.031	.026	.020
130	-	-	-	.038	-	-	-	-
140	.007	.037	.008	.039	.012	.036	.015	.031
160	.003	.019	.004	.024	.005	.025	.010	.026

TABLE IX-20 (cont'd)

STATION	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
180	.002	.007	.003	.012	.004	.018	.005	.015
200	.002	.005	.003	.004	.002	.010	.003	.011
220	-	-	.002	.003	.001	.007	.001	.009
240	-	-	-	.002	-	-	-	-
250	-	-	-	-	-	.002	-	.003

	Cycle 40		Cycle 45		Cycle 50		Cycle 55	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
0	.004	-	.001	-	.000	-	.000	-
20	.003	-	.002	-	.001	-	.000	-
40	.008	.001	.004	.001	.002	.000	.001	.000
60	.013	.004	.010	.002	.005	.001	.002	.000
80	.022	.008	.014	.003	.011	.002	.008	.000
100	.025	.011	.022	.007	.013	.004	.011	.002
120	.021	.014	.018	.011	.015	.008	.014	.004
140	.015	.026	.020	.019	.014	.014	.014	.009
160	.011	.024	.012	.020	.012	.015	.012	.013
180	.007	.019	.009	.018	.009	.015	.010	.012
200	.003	.010	.007	.013	.005	.013	.008	.013
220	.004	.010	.003	.012	.004	.010	.004	.008
250	-	.004	.003	.005	.001	.005	.002	.005
275	-	.002	-	-	.001	.004	.004	.007
300	-	-	-	-	-	-	-	.003

STATION	Cycle 60		Cycle 65		Cycle 70	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
20	.000	-	.000	-	-	-
40	.001	.001	.000	.000	-	-
60	.007	.000	.001	.000	.000	.000
80	.004	.001	.002	.000	.003	.000
100	.008	.004	.008	.002	.004	.001
120	.010	.003	.009	.001	.008	.005
140	.010	.004	.011	.004	.007	.003
160	.011	.007	.013	.010	.009	.007
180	.008	.011	.008	.014	.007	.007
190	-	-	-	-	.005	.008
200	.005	.011	.005	.014	.007	.010
215	-	-	-	-	.008	.010
220	.004	.009	.004	.009	.007	.009
225	-	-	-	-	.004	.007
240	-	-	-	-	.004	.004
250	.002	.005	.003	.005	.004	.008
275	.002	.005	.003	.005	.003	.004
300	-	.003	-	.002	.002	.003

TABLE IX-21

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 12 H. & L.W.S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 12, 350 cfs at Trenton, New Jersey
(b) Release Point Station 0+00
(c) Instantaneous Dye Release
(d) Initial Dye Concentration 2, 605 cc at 913 ppm

STATION	Cycle 3		Cycle 5		Cycle 10		Cycle 15	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-40	.000	-	-	-	-	-	-	-
-30	.004	-	.002	-	-	-	-	-
-20	.020	-	.014	-	-	-	-	-
-10	.062	.003	.031	.002	.008	-	-	-
0	.107	.007	.056	.001	.012	-	.002	-
10	.161	.010	.097	.004	.019	.001	.003	-
20	.184	.019	.115	.009	.024	.002	.007	-
30	.150	.046	-	.014	.047	.008	.010	.002
50	.023	.126	.107	.070	.061	.018	.020	.007
60	.009	.146	.061	.078	.065	.027	.028	.004
70	.000	.148	.018	.113	.061	.037	.041	.010
80	.000	.083	-	.127	.056	.032	.045	.015
90	.000	.041	.002	.104	.050	.068	.056	.020
100	-	.023	.000	.053	.032	.077	.054	.024
110	-	.004	-	.039	.018	.059	.055	.031
120	-	.002	-	.023	.009	.056	.051	.043
130	-	-	-	.007	.003	.058	.030	.050
140	-	-	-	.003	-	.054	-	.059
150	-	-	-	-	-	-	.007	.058
160	-	-	-	-	-	.016	-	.051
170	-	-	-	-	-	-	.003	-
180	-	-	-	-	-	.002	-	.024
200	-	-	-	-	-	-	-	.010

TABLE IX-21 (cont'd)

STATION	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
20	.003	-	-	-	-	-	-	-
30	.004	-	-	-	-	-	-	-
50	.010	.002	.003	-	.002	-	-	-
60	.011	-	-	.002	.001	-	.001	-
70	.020	.005	.005	-	-	-	-	-
80	.027	-	-	.004	.004	.001	.002	.000
90	.027	.008	.013	-	-	-	-	-
100	.039	-	-	.004	.008	.001	.004	.001
110	.050	.018	.023	-	-	-	-	-
120	.048	.019	-	.007	.012	.003	.005	.002
130	.041	.031	.027	-	-	-	-	-
140	-	-	-	.014	.026	.008	.013	.003
150	.015	.043	.022	-	-	-	-	-
160	-	-	-	.026	.027	.014	.020	.008
170	.016	.043	.018	-	-	-	-	-
180	-	-	-	.035	.021	.023	.015	.011
200	.004	.022	.007	.028	.013	.015	.015	.015
225	-	.012	.002	.015	.005	.018	.010	.018
250	-	.003	-	.007	.002	.013	.007	.015
275	-	-	-	.004	-	.008	.004	.010
300	-	-	-	-	-	.004	.003	.004

	Cycle 40		Cycle 45		Cycle 50	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
60	.001	-	.000	-	.000	-
80	.001	.002	.000	.000	.001	.000
100	.001	.002	.002	.000	.000	.000
120	.004	.001	.003	.002	.001	.000
140	.012	.001	.004	.001	.003	.000
160	.012	.002	.008	.000	.003	.002
170	-	-	-	-	.004	.002
180	.012	.003	.009	.003	.007	.003
190	-	-	-	-	.011	.003
200	.013	.010	.012	.005	.009	.003
215	-	-	-	-	.008	.005
225	.004	.013	.008	.010	.004	.005
240	-	-	-	-	.008	.008
250	.007	.013	.007	.009	.005	.007
275	.004	.012	.004	.007	.005	.008
300	.002	.004	.003	.007	.002	.007

TABLE IX-22

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 13 H. & L. W. S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 3,400 cfs at Trenton, New Jersey
(b) Release Point Station -155
(c) Instantaneous Dye Release
(d) Initial Dye Concentration 1,000 cc at 913 ppm

STATION	Cycle 3		Cycle 5		Cycle 10		Cycle 15	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-155	.034	.022	.004	.002	.004	.001	.000	.001
-150	.061	.033	-	-	-	-	-	-
-145	.517	.245	.101	.016	.013	.007	.003	.001
-140	.586	.527	-	-	-	-	-	-
-135	.138	.554	.382	.094	.037	.008	.004	.002
-130	.007	.332	-	-	-	-	-	-
-125	.000	.066	.129	.297	.139	.023	.044	.004
-120	-	.004	-	-	-	-	-	-
-115	-	.000	.004	.288	.170	.083	.084	.016
-105	-	-	.000	.125	.077	.129	.108	.041
-95	-	-	-	.041	.027	.162	.104	.047
-85	-	-	-	.003	.004	.159	.066	.077
-75	-	-	-	-	.002	.100	.022	.100
-65	-	-	-	-	-	.037	.010	.100
-55	-	-	-	-	-	.015	.004	.100
-45	-	-	-	-	-	-	-	.051
-35	-	-	-	-	-	-	-	.023
-25	-	-	-	-	-	-	-	.010
-15	-	-	-	-	-	-	-	.003

STATION	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-135	.001	-	-	-	-	-	-	-
-125	.012	.001	.001	-	-	-	-	-
-115	.027	.004	.005	.002	.002	-	-	-
-105	-	-	-	-	-	.002	-	-
-100	-	-	-	-	.015	.003	.005	-
-95	.080	.019	.032	.004	-	-	-	-
-90	-	-	-	-	-	-	.010	.002
-80	-	-	-	-	.027	.007	-	-
-75	.066	.055	.041	.024	-	-	-	-
-70	-	-	-	-	-	-	.021	.005
-60	-	-	-	-	.035	.012	-	-
-55	.019	.081	.030	.043	-	-	-	-
-50	-	-	-	-	-	-	.024	.014
-45	.010	.066	-	-	-	-	-	-
-40	-	-	.019	.057	.027	.031	-	-
-35	.003	.051	-	-	-	-	-	-
-30	-	-	.010	.037	-	-	.014	.026
-25	-	.024	-	-	-	-	-	-
-20	-	-	.004	.035	.008	.035	-	-
-15	-	.014	-	-	-	-	-	-
-10	-	-	-	-	.007	.027	.007	.025
-5	-	.012	-	.024	-	-	-	-

TABLE IX-22 (cont'd)

STATION	Cycle 20		Cycle 25		Cycle 30		Cycle 35	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
0	-	-	-	-	.004	.025	.008	.020
5	-	.004	-	.011	-	-	-	-
10	-	-	-	-	-	.013	.005	.020
15	-	-	-	.005	-	-	-	-
20	-	-	-	.004	-	.008	-	.013
30	-	-	-	-	-	.005	-	.012
40	-	-	-	-	-	-	-	.010

STATION	Cycle 40		Cycle 45		Cycle 50		Cycle 55	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-90	.005	-	.003	-	-	-	-	-
-80	-	-	.005	-	.002	-	.005	-
-75	.009	-	-	-	-	-	-	-
-70	-	-	-	.002	.004	-	.005	-
-65	-	.005	-	-	-	-	-	-
-60	-	-	.012	.003	-	.002	-	.002
-55	.019	.008	-	-	-	-	-	-
-50	-	-	-	-	.010	.003	.008	.002
-40	-	-	.016	.008	-	-	.007	.003
-35	.021	.008	-	-	-	-	-	-
-30	-	-	-	-	.013	.008	.012	.004
-20	-	-	.016	.011	-	-	.008	.007
-15	.014	.016	-	-	-	-	-	-
-10	-	-	-	-	.013	.012	.008	.009
0	.007	.022	.011	.014	-	-	.009	.008
10	-	-	-	-	.009	.009	.010	.010
15	.005	.017	.008	.011	-	-	-	-
20	-	-	-	-	-	-	.005	.008
25	.004	.012	.003	.011	-	-	-	-
30	-	-	-	-	.007	.018	.009	.012
35	-	-	.004	.008	-	-	-	-
40	-	.010	-	-	.005	.010	.004	.011
45	-	-	-	.009	-	-	-	-
50	-	.009	-	-	.007	.008	.007	.010
55	-	-	-	.008	-	-	-	-
60	-	.004	-	-	-	.008	.005	.005
65	-	-	-	.005	-	-	-	-
70	-	-	-	-	-	.007	-	.008
80	-	-	-	-	-	-	-	.007

TABLE IX-23

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) TEST 14 H. & L. W. S. CONCENTRATION READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

(a) Flow 5, 500 cfs at Trenton, New Jersey
(b) Release Point Station -155
(c) Instantaneous Dye Release
(d) Initial Dye Concentration 1, 000 cc at 913 ppm

STATION	Cycle 3		Cycle 5		Cycle 7		Cycle 10	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-155	.002	.005	.003	.000	.002	.003	.002	-
-150	.005	.007	.035	.001	-	-	.002	.002
-145	.076	.030	.038	-	.005	.005	.002	.003
-140	.148	.043	.042	.015	-	-	.003	.004
-135	.312	.087	.073	.025	.023	.007	-	-
-130	.398	.138	.106	.027	-	-	.009	.004
-125	.081	.203	.227	.078	.088	.012	-	-
-120	.012	.273	.235	.093	-	-	.030	.005
-115	-	.329	-	-	.168	.045	-	-
-110	-	.260	.090	.140	-	-	.083	.015
-105	-	.172	.026	.204	.150	.082	-	-
-100	-	.102	.004	.230	-	-	.104	.031
-95	-	.002	.004	.193	.067	.112	-	-
-90	-	.012	.004	.181	-	-	.119	.047
-85	-	-	.001	.107	.009	.169	-	-
-80	-	-	-	.035	-	-	.088	.084
-75	-	-	-	.022	.001	.145	-	-
-70	-	-	-	.009	.002	.118	.008	.115
-65	-	-	-	.005	-	.089	-	-
-60	-	-	-	-	-	-	.008	.118
-55	-	-	-	-	-	.028	.004	-
-50	-	-	-	-	-	-	.003	.104
-45	-	-	-	-	-	.015	-	-
-40	-	-	-	-	-	-	-	.041
-35	-	-	-	-	-	-	-	.035
-30	-	-	-	-	-	-	-	.021
-25	-	-	-	-	-	-	-	.014
-20	-	-	-	-	-	-	-	.009

TABLE IX-23 (cont'd)

STATION	Cycle 15		Cycle 20		Cycle 25		Cycle 30	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-135	.002	-	-	-	-	-	-	-
-125	.001	-	-	-	-	-	-	-
-115	.005	.002	-	-	-	-	-	-
-110	-	-	.003	-	-	-	-	-
-105	-	.004	-	-	-	-	-	-
-100	.033	-	-	-	-	-	-	-
-95	-	-	.009	-	.003	-	-	-
-85	.046	.007	-	.002	.005	-	.001	-
-80	-	-	.018	-	-	-	-	-
-75	-	-	-	.004	.010	-	.002	-
-70	.076	.016	-	-	-	.002	-	-
-65	-	-	-	-	-	-	.008	-
-60	-	-	.048	.008	-	.003	-	-
-55	.065	.053	-	-	.025	-	-	-
-50	-	-	-	-	-	.004	-	-
-45	-	-	-	-	-	-	.016	.002
-40	.049	.059	.028	-	-	-	-	-
-35	-	-	-	-	.038	.010	-	.004
-30	.008	.062	-	-	-	-	-	-
-25	.021	-	.026	-	-	-	.021	.007
-20	-	.050	-	.041	-	-	-	-
-15	-	-	.012	-	.025	.027	-	-
-10	-	.038	-	-	-	-	-	-
-5	-	-	.008	-	-	-	.023	.004
0	-	.022	.000	.042	-	-	-	-
5	-	-	.005	-	.018	.031	-	-
10	-	.012	-	.034	-	-	-	-
15	-	-	-	-	.011	-	.014	.021
20	-	-	-	.022	-	.028	-	-
25	-	-	-	-	.005	-	.012	.022
30	-	-	.000	.015	-	.022	-	-
35	-	-	-	-	-	-	.009	.020
40	-	-	-	-	-	.022	-	-
45	-	-	-	-	-	-	-	.014
50	-	-	-	-	-	.015	-	-
55	-	-	-	-	-	-	-	.015
65	-	-	-	-	-	-	-	.010

TABLE IX-23 (cont'd)

STATION	Cycle 35		Cycle 40		Cycle 45		Cycle 50	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-70	.002	-	-	-	-	-	-	-
-60	.007	-	.001	-	-	-	-	-
-50	.007	-	.002	-	-	-	-	-
-45	-	-	-	-	.003	-	-	-
-40	-	-	.004	-	-	-	-	-
-35	-	.002	-	-	.004	-	.003	-
-30	.013	-	-	.001	-	-	-	-
-25	-	.004	-	-	.007	-	.004	-
-20	-	-	.012	-	-	-	-	-
-15	-	-	-	-	-	-	.005	-
-10	.020	.008	-	-	-	-	-	-
-5	-	-	-	-	.012	.002	.004	-
0	-	-	.013	.004	-	-	-	-
5	-	-	-	-	-	-	.007	.002
10	.020	.015	-	-	-	-	-	-
15	-	-	-	-	.011	.007	.010	.003
20	-	-	.015	.011	-	-	-	-
25	.013	.014	-	-	-	-	.009	.005
35	.010	-	-	-	.012	.010	.009	.007
40	-	-	.012	.013	-	-	-	-
45	.007	.014	-	-	-	-	.010	.009
55	.008	-	.010	-	.013	.010	.010	.009
60	-	.011	-	.013	-	-	-	-
65	.004	-	-	-	-	-	.010	.008
70	-	.007	.007	-	-	-	-	-
75	.004	-	-	-	.010	.012	.010	.007
80	-	.009	.005	.012	-	-	-	-
85	-	-	-	-	-	-	.007	.008
90	-	.008	.003	.008	.007	.011	-	-
95	-	-	-	-	-	-	.005	.010
100	-	-	-	.008	.005	-	-	-
105	-	-	-	-	-	.010	.005	.009
110	-	-	-	.007	.005	-	-	-
115	-	-	-	-	-	.009	.005	.008
120	-	-	-	.007	-	-	-	-
125	-	-	-	-	-	.009	.004	.008
135	-	-	-	-	-	-	-	.008
145	-	-	-	-	-	-	-	.004

TABLE IX-24

EXPERIMENTAL RESULTS - FLOAT LOCATIONS AT HIGH WATER SLACK AND LOW WATER SLACK AT 3, 400 CFS

	Station Position		Net Movement,
Tidal Cycle	HWS	LWS	Ft. (HWS)
	-155	-146	
1	-148	-136	7,000
2	-142.5	-129.5	5,500
3	-138	-124	4,500
4	-136	-119.75	2,000
5	-133	-111	3,000
6	-126	-101	7,000
7	-121	- 96	5,000
8	-119.5	- 92	1,500
9	-115	- 86	4,500
10	-112.5	- 81	2,500
11	-107.5	- 74	5,000
12	-104	- 71.5	3,500
13	-101	- 66.5	3,000
14	- 96.5	- 62	4,500
15	- 93	- 58.5	3,500
16	- 92	- 53	1,000
17	- 87	- 47	5,000
18	- 82	- 43	5,000
19	- 79	- 39.5	3,000
20	- 74.5	- 32	4,500
21	- 68	- 24	6,500
22	- 63	- 20	5,000
23	- 62	- 18	1,000
24	- 60.5	- 16	1,500
25	- 57	- 12.5	3,500
26	- 54	- 12	3,000
27	- 53	- 12	1,000
28	- 52	- 10	1,000
29	- 51	- 10	1,000
30	- 50	- 6	1,000
31	- 46.5	- 3	3,500
32	- 45.5	- 3	1,000
33	- 43	0	2,500
34	- 36.5	+ 7.5	6,500
35	- 33.5	+ 12	3,000
36	- 31.5	+ 14.5	2,000
37	- 28.5	+ 17.5	3,000
38	- 28	+ 17.5	500
39	- 24	+ 19	4,000
40	- 24	+ 21.5	0
41	- 23	+ 24	1,000
42	- 21.5	-	1,500
or 21 days	-	-	133,500 Total

TABLE IX-25

EXPERIMENTAL RESULTS - FLOAT LOCATIONS AT HIGH WATER SLACK AND LOW WATER SLACK AT 7,000 CFS

Tidal Cycle	Station Position		Net Movement,
	HWS	LWS	Ft. (HWS)
	-155	-140.5	
1	-143.5	-126.0	11,500
2	-134.5	-110.0	9,000
3	-126.0	- 98.0	8,500
4	-118.0	- 85.5	8,000
5	-109.5	- 73.5	8,500
6	-101.0	- 63.5	8,500
7	- 93.0	- 51.5	8,000
8	- 85.0	- 45.0	8,000
9	- 78.5	- 34.5	6,500
10	- 70.0	- 23.5	8,500
11	- 60.5	- 15.5	9,500
12	- 55.5	- 12.0	5,000
13	- 52.0	- 11.0	3,500
14	- 48.0	- 3.5	4,000
15	- 44.0	+ 1.5	4,000
16	- 38.5	+ 6.0	5,500
17	- 35.0	+ 11.0	3,500
18	- 32.5	+ 15.5	2,500
19	- 27.0	+ 22.0	5,500
20	- 19.5	+ 30.0	7,500
or 10 days	-	-	135,500 Total

TABLE IX-26

EXPERIMENTAL RESULTS - FLOAT LOCATIONS AT HIGH WATER SLACK AND LOW WATER SLACK AT 12, 350 CFS

Tidal Cycle	Station Position		Net Movement,
	HWS	LWS	Ft. (HWS)
	-155.0	-129.5	
1	-135.0	- 05.5	20,000
2	-119.5	- 83.5	15,500
3	-104.0	- 62.0	15,500
4	- 89.0	- 43.5	15,000
5	- 76.0	- 28.5	13,000
6	- 63.0	- 15.5	13,000
7	- 51.0	- 7.0	12,000
8	- 46.5	+ 2.0	4,500
9	- 37.5	+ 9.0	9,000
10	- 30.0	+ 20.0	7,500
11	- 20.0	+ 30.0	10,000
12	- 13.5	+ 40.5	6,500
13	+ 2.5		16,000
or 6.5 days			157,500 Total

TABLE IX-27

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) AT CYCLE 180
READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

STATION	Test No. 1		Test No. 2		Test No. 3		Test No. 5	
	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.	H. W. S.	L. W. S.
-127	.008	-	-	-	-	-	-	-
-120	.039	-	-	-	-	-	-	-
-110	.122	-	-	-	-	-	-	-
-100	.207	-	-	-	-	-	-	-
-90	.211	-	-	-	-	-	-	-
-80	.198	-	-	-	-	-	-	-
-70	.180	-	.005	-	-	-	-	-
-60	.162	.197	.015	.001	-	-	-	-
-50	.177	-	.022	-	.003	-	-	-
-40	.180	-	.062	-	.009	-	-	-
-35	.177	.194	.081	.004	.015	.0014	-	-
-30	.170	-	.108	-	.025	-	-	-
-20	.142	-	.145	-	.034	.0028	-	-
-10	.111	-	.126	-	.057	.0034	-	-
0	.138	.140	.166	.128	.073	.011	.003	.001
10	.116	-	.141	.099	.077	.024	.001	.001
20	.123	-	.141	.136	.111	.039	.000	.000
30	.097	-	.124	.138	.130	.054	.003	.002
40	.089	-	.122	.145	.147	.069	.005	.002
50	.071	.101	.126	.147	.135	.089	.007	.003
60	.093	-	.119	.113	.111	.112	.001	.002
70	.076	-	.113	.126	.117	-	.012	.005
80	.083	.088	.092	.092	.135	.142	.026	.007
90	.059	-	.093	-	.115	-	.033	.009
100	.049	-	.090	.106	.096	.127	.045	.012
110	.050	-	.074	-	.090	-	.050	.014
120	.046	-	.067	-	.085	.123	.059	.025
130	.035	.066	.058	.089	.060	.115	.076	.031
140	.031	-	.044	-	.055	.108	.081	.035
150	.027	-	.036	.076	.050	.070	.080	.051
160	.020	-	.030	-	.047	.082	.074	.055
170	.022	.032	.033	.064	.043	-	.077	.068
180	.011	-	.025	-	.042	-	.050	.080
190	.012	-	.023	-	.038	.056	.051	.081
200	.014	.022	.022	.041	.027	.042	.035	.065
210	-	-	-	-	-	-	.035	.074
225	.012	.018	.012	.028	.020	.037	.025	.060
250	.007	.012	.010	.014	.012	.027	.019	.041
275	.004	-	.004	.013	-	.010	.011	.027
300	.003	.005	.004	.008	.004	.008	.016	.005

Test No. 4 did not run 180 cycles

TABLE IX-27 (cont'd)

EXPERIMENTAL RESULTS (UNCORRECTED FOR DYE LOSS) AT CYCLE 180 READINGS EXPRESSED AS PERCENT OF INITIAL CONCENTRATION

STATION	Test No. 6		Test No. 7		Test No. 8		Test No. 9	
	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.	H.W.S.	L.W.S.
-40	-	-	.004	-	-	-	-	-
-30	.001	-	.008	-	.002	-	-	-
-20	.011	-	.019	-	.003	-	-	-
-10	.015	-	.028	.001	.009	-	-	-
0	.022	.001	.044	.001	.018	-	.011	.001
10	.046	.004	.066	.009	.038	.002	.027	.003
20	.054	.009	.082	.020	.045	.003	.031	.009
30	.072	.015	.104	.034	.058	.007	.042	.010
40	.089	.023	.050	.038	.073	.010	.066	.020
50	.094	.035	.103	.067	.084	.026	.064	.034
60	.087	.048	.113	.090	.079	.043	.069	-
70	.072	.067	.101	.105	.054	.055	.066	.046
80	.082	.079	.105	.114	.076	.069	.065	.071
90	.087	.079	.100	.119	.066	.076	.058	.072
100	.082	.081	.082	.119	.073	.073	.058	.066
110	.071	.088	.090	.113	.064	.073	.054	.066
120	.066	.087	.074	.107	.062	.074	.058	.055
130	.062	.077	.071	.099	.057	.066	.032	.065
140	.058	.083	.066	.104	.058	.074	.049	.058
150	.051	.066	.057	.094	.053	.072	.045	.054
160	.044	.057	.049	.088	.053	.061	.046	.050
170	.046	.061	.049	.082	.037	.049	.044	.050
180	.046	.062	.044	.072	.042	.059	.038	.051
190	.036	.050	.038	.062	.039	.053	.037	.042
200	.028	.046	.031	.051	.032	.053	.028	.044
210	.024	.046	.026	.046	.028	.050	.023	.044
225	.022	.035	.022	.048	.026	.046	.026	.041
250	.018	.031	.019	.037	.020	.037	.014	.031
275	.009	.024	.008	.027	.014	.027	.012	.024
300	.007	.016	.005	.019	.010	.018	.005	.013

TABLE X-1

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 1
DISCHARGE POINT STATION -100
TRENTON FLOW 3,400 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles^{-1}	t_o, cycles	C	L, %	k, cycles^{-1}	t_o, cycles	C
-60	0.1620	0.01690	9.20	1.43	0.1744	0.02700	0.00	1.00
-35	0.1600	0.01350	17.60	1.73	0.1676	0.02000	6.84	1.37
0	0.1384	0.00700	27.00	1.54	0.1600	0.01300	15.80	1.60
50	0.1140	0.00476	38.60	1.53	0.1300	0.00720	29.12	1.62
80	0.0962	0.00310	59.84	1.53	0.1200	0.00500	39.90	1.59
130	0.0880	0.00165	62.20	1.27	0.1060	0.00299	50.36	1.41
170	0.0710	0.00125	77.20	1.25	0.0873	0.00210	70.10	1.40
200	0.0700	0.00085	95.44	1.21	0.0680	0.00180	80.50	1.39
225	-	-	-	-	0.0750	0.00120	88.98	1.28
250	-	-	-	-	0.0650	0.00090	101.20	1.23

NOTE: L, k, & t_o are Computer Values

$C = 10^{kt_o}$

TABLE X-2

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 2
DISCHARGE POINT STATION 0+00
TRENTON FLOW 3,400 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles $^{-1}$	t_o, cycles	C	L, %	k, cycles $^{-1}$	t_o, cycles	C
-35	0.0932	0.01950	0.00	1.00	-	-	-	-
0	0.1400	0.01610	1.98	1.08	0.0629	0.01980	0.00	1.00
50	0.1217	0.00760	12.42	1.24	0.1440	0.01130	1.48	1.04
80	0.1061	0.00520	21.94	1.30	0.1287	0.00682	10.36	1.18
130	0.0894	0.00250	35.00	1.22	0.0984	0.00600	28.40	1.48
170	0.0722	0.00175	44.20	1.20	0.0915	0.00317	35.80	1.30
200	0.0420	0.00218	61.16	1.36	0.0815	0.00195	44.70	1.22
225	-	-	-	-	0.0652	0.00178	47.90	1.22

TABLE X-3

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 3
DISCHARGE POINT STATION 50
TRENTON FLOW 3,400 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles^{-1}	t_o, cycles	C	L, %	k, cycles^{-1}	t_o, cycles	C
0	0.0710	0.00812	2.12	1.04	-	-	-	-
50	0.1370	0.00985	0.00	1.00	0.0855	0.01060	1.50	1.04
80	0.1160	0.00660	5.84	1.09	0.1320	0.01170	0.00	1.00
130	0.0930	0.00314	15.80	1.12	0.1240	0.00480	5.32	1.06
170	0.0852	0.00194	27.40	1.13	0.1050	0.00320	12.68	1.10
200	0.0690	0.00140	39.46	1.14	0.0866	0.00239	24.30	1.14
225	-	-	-	-	0.0850	0.00170	26.72	1.11
250	-	-	-	-	0.0691	0.00143	37.40	1.13

TABLE X-4

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 4
DISCHARGE POINT STATION 130
TRENTON FLOW 3, 400 cfs

DYE CONCENTRATION = 913 p. p. m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles^{-1}	t_o, cycles	C	L, %	k, cycles^{-1}	t_o, cycles	C
50	0. 0399	0. 00235	6. 52	1. 04	-	-	-	-
80	0. 0648	0. 00744	1. 30	1. 02	0. 0339	0. 00292	10. 00	1. 07
130	0. 0822	0. 00881	0. 00	1. 00	0. 0694	0. 01090	0. 00	1. 00
170	0. 0542	0. 00628	5. 54	1. 08	0. 0847	0. 01050	0. 00	1. 00
200	0. 0411	0. 00380	8. 54	1. 08	0. 0657	0. 00602	4. 40	1. 06
225	0. 0302	0. 00315	13. 50	1. 10	0. 0549	0. 00508	5. 76	1. 07
250	-	-	-	-	0. 0431	0. 00360	15. 92	1. 14

TABLE X-5

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 5
DISCHARGE POINT STATION 170
TRENTON FLOW 3,400 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles $^{-1}$	t_o, cycles	C	L, %	k, cycles $^{-1}$	t_o, cycles	C
80	0.0263	0.00522	15.80	1.21	-	-	-	-
130	0.0690	0.00920	2.02	1.04	0.0319	0.00569	8.80	1.13
170	0.0706	0.00950	0.00	1.00	0.0648	0.00843	0.00	1.00
200	0.0460	0.00520	2.02	1.02	0.0703	0.00920	0.00	1.00
225	0.0377	0.00350	8.06	1.07	0.0593	0.00732	0.00	1.00
250	0.0286	0.00275	11.94	1.08	0.0451	0.00499	3.36	1.04

TABLE X-6

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 6
DISCHARGE POINT STATION 50
TRENTON FLOW 5,500 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles^{-1}	t_o, cycles	C	L, %	k, cycles^{-1}	t_o, cycles	C
0	0.0232	0.01890	3.90	1.18	-	-	-	-
25	0.0635	0.02300	0.00	1.00	-	-	-	-
50	0.0861	0.01900	0.00	1.00	0.0341	0.01960	0.00	1.00
80	0.0786	0.01270	5.30	1.17	0.0860	0.02100	0.00	1.00
100	0.0743	0.01030	10.30	1.29	0.0826	0.01490	1.00	1.03
130	0.0616	0.00745	17.10	1.34	0.0800	0.01120	7.00	1.20
170	0.0544	0.00470	26.20	1.33	0.0674	0.00728	17.30	1.34
200	0.0465	0.00300	35.44	1.28	0.0580	0.00534	24.10	1.35
225	0.0430	0.00225	43.28	1.25	0.0518	0.00472	30.00	1.39
250	-	-	-	-	0.0391	0.00360	34.10	1.33
275	-	-	-	-	0.0328	0.00324	38.80	1.34

TABLE X-7

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 7
DISCHARGE POINT STATION 50
TRENTON FLOW 4,500 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles $^{-1}$	t_o, cycles	C	L, %	k, cycles $^{-1}$	t_o, cycles	C
-20	0.0194	0.00937	4.48	1.10	-	-	-	-
0	0.0468	0.00937	0.00	1.00	-	-	-	-
25	0.0954	0.01440	0.00	1.00	0.0278	0.01200	4.96	1.15
50	0.1170	0.01130	0.00	1.00	0.0612	0.01310	0.00	1.00
80	0.1090	0.00655	4.30	1.07	0.1121	0.01600	0.00	1.00
100	0.1060	0.00558	8.94	1.12	0.1070	0.01020	0.00	1.00
130	0.0924	0.00376	14.80	1.14	0.0995	0.00790	7.32	1.14
170	0.0783	0.00271	20.58	1.14	0.0930	0.00417	15.60	1.16
200	0.0750	0.00170	26.68	1.11	0.0785	0.00317	18.90	1.15
225	0.0658	0.00125	30.48	1.09	0.0716	0.00269	26.00	1.17
250	0.0600	0.00090	33.60	1.07	0.0590	0.00205	29.64	1.15
275	-	-	-	-	0.0575	0.00160	33.06	1.13
300	-	-	-	-	0.0500	0.00123	43.14	1.13

TABLE X-8

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 8
DISCHARGE POINT STATION 50
TRENTON FLOW 7,000 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles $^{-1}$	t_o, cycles	C	L, %	k, cycles $^{-1}$	t_o, cycles	C
0	0.0145	0.02100	6.14	1.34	-	-	-	-
25	0.0503	0.02500	0.00	1.00	-	-	-	-
50	0.0700	0.02200	0.00	1.00	0.0225	0.02000	0.00	1.00
80	0.0691	0.01470	6.68	1.25	0.0735	0.02145	0.00	1.00
100	0.0688	0.01190	10.60	1.34	0.0721	0.01680	2.38	1.10
130	0.0610	0.00800	17.00	1.37	0.0717	0.01190	6.24	1.19
170	0.0530	0.00490	20.14	1.26	0.0591	0.00870	13.82	1.32
200	0.0443	0.00375	27.60	1.27	0.0530	0.00600	21.40	1.34
225	0.0401	0.00299	32.10	1.25	0.0522	0.00490	26.86	1.35
250	0.0380	0.00210	36.80	1.19	0.0450	0.00385	32.00	1.33
275	0.0350	0.00146	41.86	1.15	0.0400	0.00310	36.98	1.30
300	-	-	-	-	0.0310	0.00245	43.16	1.28

TABLE X-9

DELAWARE RIVER MODEL TEST STUDY
ANALOG COMPUTER "FIT" OF DYE BUILD-UP

TEST NO. 9
DISCHARGE POINT STATION 50
TRENTON FLOW 8,000 cfs

DYE CONCENTRATION = 913 p.p.m.
DYE DISCHARGE RATE = 100 ml/cycle

STATION	HIGH WATER SLACK				LOW WATER SLACK			
	L, %	k, cycles^{-1}	t_o, cycles	C	L, %	k, cycles^{-1}	t_o, cycles	C
25	0.0400	0.03153	1.28	1.10	-	-	-	-
50	0.0610	0.02550	0.00	1.00	0.0160	0.02400	4.48	1.28
80	0.0580	0.01800	5.04	1.23	0.0640	0.02850	0.00	1.00
100	0.0588	0.01460	7.24	1.28	0.0590	0.02300	1.64	1.09
130	0.0520	0.01020	16.00	1.46	0.0590	0.01750	6.24	1.29
170	0.0450	0.00650	21.68	1.38	0.0520	0.01210	17.52	1.63
200	0.0380	0.00460	28.08	1.35	0.0470	0.00850	23.50	1.58
225	0.0315	0.00340	30.68	1.27	0.0400	0.00772	27.80	1.64
250	0.0298	0.00250	36.52	1.23	0.0353	0.00558	31.60	1.50
275	-	-	-	-	0.0283	0.00460	34.72	1.44
300	-	-	-	-	0.0210	0.00350	43.60	1.42

TABLE XI-1

MASS ANALYSIS CALCULATIONS
TEST 8 (HWS) UNCORRECTED

		20 Cycles			40 Cycles	60 Cycles
Station Number	Volume (cc)	Ave. Dye (ppm)	Total Dye	Accum. Dye (ppm)	Accum. Dye (ppm)	Accum. Dye (ppm)
-52.5	106, 672	0.00	0	0	0	0.
-47.5	106, 3 89	0.00	0	0	0	0.
-42.5	104, 208	0.00	0	0	0	0.
-37.5	105, 341	0.00	0	0	0	0.
-32.5	105, 341	0.00	0	0	0	632.
-27.5	122, 160	0.00	0	0	977.	2, 587.
-22.5	122, 160	0.00	0	0	2199.	5, 885.
-17.5	121, 679	0.010	1217.	1, 217.	3651.	10, 753.
-12.5	121, 679	0.024	2920	4, 137.	5719.	17, 932.
- 7.5	121, 679	0.040	4868	9, 005.	8518.	27, 666.
- 2.5	121, 197	0.060	7272	16, 277.	12, 120.	40, 998.
+ 2.5	121, 762	0.090	10959	27, 236.	17, 047.	60, 480.
⋮	⋮	⋮	⋮	⋮	⋮	⋮
+337.5				Σ1, 210, 357	Σ2, 477, 610	Σ3, 540, 664

	80 Cycles	100 Cycles	120 Cycles	140 Cycles	160 Cycles	180 Cycles
Station Number	Accum. Dye (ppm)	Accum. Dye (ppm)	Accum. Dye (ppm)	Accum. Dye (ppm)	Accum. Dye (ppm)	Accum. Dye (ppm)
-52.5	0.	0.	0	0	0	0
-47.5	0.	0.	0	0	0	0
-42.5	0.	0.	0	0	0	0
-37.5	421.	421.	527.	527.	327	632
-32.5	1790.	1790.	2002.	2002.	1802	1212
-27.5	4478.	4478.	4690.	4812.	4612	4144
-22.5	8509.	8509.	8721.	8965.	8765	
-17.5	14228.	14228.	14562.	14806.		
-12.5	22137.	22137.	22593.			
- 7.5	32845.	32845.				
- 2.5	47389.					
+ 2.5						
⋮	⋮	⋮	⋮	⋮	⋮	⋮
+337.5	Σ4, 857, 042	Σ4, 857, 042	Σ5, 357, 303	Σ5, 748, 981	Σ6, 077, 986	Σ6, 363, 361

TABLE XI-2

DELAWARE RIVER MODEL TEST
SERIES 1-9, (HWS)
AMOUNT OF DYE PRESENT, MICROGRAMS

Test No.	AFTER CYCLE NUMBER								
	20	40	60	80	100	120	140	160	180
1.	1, 519, 967	2, 590, 618	3, 693, 832	4, 676, 772	5, 611, 234	6, 351, 433	7, 010, 062	7, 739, 745	8, 556, 474
2.	1, 590, 956	2, 855, 605	3, 934, 056	4, 931, 465	5, 703, 351	6, 271, 164	6, 936, 509	7, 448, 232	7, 999, 085
3.	1, 253, 916	2, 612, 459	3, 818, 350	4, 839, 735	5, 592, 540	6, 344, 320	6, 815, 052	7, 317, 832	7, 848, 029
4.	1, 213, 534	2, 318, 808	3, 196, 138	3, 914, 523	4, 441, 253	4, 735, 461	5, 055, 588	5, 342, 929	5, 596, 285
5.	1, 304, 987	2, 345, 480	3, 091, 414	3, 710, 922	4, 154, 613	4, 527, 599	4, 808, 346	5, 070, 281	5, 345, 353
6.	1, 356, 900	2, 565, 680	3, 540, 339	4, 334, 832	4, 937, 499	5, 392, 614	5, 830, 545	6, 193, 846	6, 548, 557
7.	1, 456, 517	2, 770, 089	4, 012, 362	4, 958, 369	5, 765, 736	6, 309, 243	6, 972, 900	7, 448, 009	7, 852, 371
8.	1, 210, 357	2, 477, 670	3, 540, 664	4, 301, 585	4, 857, 042	5, 357, 303	5, 748, 981	6, 077, 986	6, 363, 361
9.	1, 162, 393	2, 365, 870	3, 233, 378	3, 893, 238	4, 400, 737	4, 809, 715	5, 123, 461	5, 391, 728	5, 600, 684
Total Dye Released*	2×10^6	4×10^6	6×10^6	8×10^6	10×10^6	12×10^6	14×10^6	16×10^6	18×10^6

* Based upon 1000 p. p. m. concentration

TABLE XI-3

DELAWARE RIVER MODEL TEST
SERIES 1-9 (HWS)
CENTER OF MASS STATION LOCATION, UNCORRECTED FOR DYE LOSS

Test No.	AFTER CYCLE NUMBER								
	20	40	60	80	100	120	140	160	180
1.	-84.92	-66.09	-49.39	-35.05	-22.98	-13.23	-4.63	4.45	16.54
2.	- 3.06	6.30	18.55	35.08	39.10	46.48	48.01	60.90	63.58
3.	47.03	56.78	61.77	68.24	73.81	80.61	83.89	87.07	92.15
4.	125.38	129.04	133.42	136.88	139.02	139.15	140.31	142.10	143.68
5.	156.28	157.72	159.36	160.11	162.81	164.56	165.91	167.42	168.88
3.	47.03	56.78	61.77	68.24	73.81	80.61	83.89	87.07	92.15
7.	51.60	62.11	72.97	78.77	87.93	93.12	97.56	102.70	108.14
6.	52.34	66.33	78.89	89.84	97.80	105.12	112.49	117.86	123.22
8.	58.87	75.97	94.36	106.24	115.66	122.70	128.42	133.91	138.71
9.	57.86	82.70	98.77	117.79	122.35	130.17	136.05	141.22	145.07

TABLE XI-4

DELAWARE RIVER MODEL TEST
SERIES 1-9, (HWS)
RATIO OF DYE RELEASED TO DYE MEASURED

Test No.	AFTER CYCLE NUMBER								
	20	40	60	80	100	120	140	160	180
1.	1.32	1.54	1.62	1.71	1.78	1.89	2.00	2.07	2.10
2.	1.26	1.40	1.53	1.62	1.75	1.91	2.02	2.15	2.25
3.	1.60	1.53	1.57	1.65	1.79	1.89	2.05	2.19	2.29
4.	1.65	1.73	1.88	2.04	2.25	2.53	2.77	3.00	3.21
5.	1.53	1.71	1.94	2.16	2.41	2.65	2.91	3.16	3.37
3.	1.60	1.53	1.57	1.65	1.79	1.89	2.05	2.19	2.29
7.	1.37	1.44	1.50	1.61	1.73	1.90	2.01	2.15	2.29
6.	1.47	1.50	1.69	1.85	2.03	2.23	2.40	2.58	2.75
8.	1.65	1.61	1.69	1.86	2.06	2.24	2.44	2.63	2.83
9.	1.72	1.69	1.86	2.05	2.29	2.50	2.73	2.97	3.21

TABLE XV-1

STATION BREAKDOWN FOR GOMPERTZ CALCULATIONS
TEST 8 (HWS)

STATION	x	Y	log Y
-50	0	0.00585	7.7673 -10
-40	1	0.01450	8.1615 -10
-30	2	0.02620	8.4182 -10
-20	3	0.04105	8.6138 -10
-10	4	0.05915	8.7720 -10
0	5	0.08015	8.9040 -10
+10	6	0.10330	9.0143 -10
20	7	0.12790	9.1065 -10
30	8	0.15275	9.1837 -10
$\sum_1$ log Y	-	-	77.9413 -90
40	9	0.17675	9.2473 -10
50	10	0.19875	9.2980 -10
60	11	0.21835	9.3397 -10
70	12	0.23565	9.3718 -10
80	13	0.25090	9.3998 -10
90	14	0.26425	9.4220 -10
100	15	0.27595	9.4408 -10
110	16	0.28620	9.4568 -10
120	17	0.29520	9.4700 -10
$\sum_2$ log Y	-	-	84.4462 -90
130	18	0.30315	9.4815 -10
140	19	0.31025	9.4920 -10
150	20	0.31655	9.5004 -10
160	21	0.32215	9.5085 -10
170	22	0.32720	9.5145 -10
180	23	0.33175	9.5204 -10
190	24	0.33585	9.5258 -10
200	25	0.33955	9.5305 -10
210	26	0.34290	9.5354 -10
$\sum_3$ log Y	-	-	85.6090 -90

TABLE XV-3
APPLICATION OF GOMPERTZ COEFFICIENTS
TEST 8 (HWS)

x	b^x	$(\log a)\ b^x$	$\log Y_c$	Y_c	ΔY_c
0	1.00000	-1.67078	-2.13445	0.00734	-
1	0.82600	-1.38006	-1.84373	0.01433	0.00699
2	0.68228	-1.13994	-1.60361	0.02493	0.01060
3	0.56356	-0.94158	-1.40525	0.03930	0.01437
4	0.46550	-0.77775	-1.24142	0.05735	0.01805
5	0.38450	-0.64241	-1.10608	0.07835	0.0210
6	0.31760	-0.53064	-0.99431	0.10125	0.0229
7	0.26234	-0.43831	-0.90198	0.12525	0.0240
8	0.21669	-0.36204	-0.82571	0.14940	0.02415
9	0.17899	-0.29905	-0.76272	0.17270	0.0233
10	0.14784	-0.24701	-0.71068	0.19470	0.0220
11	0.12212	-0.20404	-0.66771	0.21480	0.0201
12	0.10087	-0.16853	-0.63220	0.2333	0.0185
13	0.08332	-0.13921	-0.60288	0.2495	0.0162
14	0.06882	-0.11498	-0.57865	0.2640	0.0145
15	0.05685	-0.09498	-0.55865	0.2760	0.0120
16	0.04696	-0.07846	-0.54213	0.2868	0.0108
17	0.03878	-0.06479	-0.52846	0.2960	0.0092
18	0.03204	-0.05353	-0.51720	0.3040	0.0080
19	0.02646	-0.04421	-0.50788	0.3106	0.0066
20	0.02186	-0.03652	-0.50019	0.3155	0.0049
21	0.01801	-0.03009	-0.49376	0.3208	0.0053
22	0.02488	-0.02486	-0.48853	0.3245	0.0037
23	0.01229	-0.02053	-0.48420	0.3278	0.0033
24	0.01015	-0.01696	-0.48063	0.3305	0.0027
25	0.00838	-0.01400	-0.47767	0.3330	0.0025
26	0.00693	-0.01158	-0.47525	0.3347	0.0017

TABLE XV-4

STATION BREAKDOWN FOR GOMPERTZ CALCULATIONS
TEST - 7 (HWS)

STATION	x	Y	log Y
-50	0	0.00190	7.2785 -10
-40	1	0.00476	7.6775 -10
-30	2	0.00885	7.9468 -10
-20	3	0.01442	8.1590 -10
-10	4	0.02175	8.3375 -10
0	5	0.03117	8.4937 -10
+10	6	0.04297	8.6330 -10
20	7	0.05700	8.7560 -10
30	8	0.07140	8.8540 -10
$\sum_1$ log Y	-	-	74.1360 -90
40	9	0.08465	8.9280 -10
50	10	0.09605	8.9825 -10
60	11	0.10570	9.0233 -10
70	12	0.11390	9.0561 -10
80	13	0.12094	9.0820 -10
90	14	0.12707	9.1060 -10
100	15	0.13240	9.1220 -10
110	16	0.13708	9.1370 -10
120	17	0.14123	9.1497 -10
$\sum_2$ log Y	-	-	81.5866 -90
130	18	0.14493	9.1520 -10
140	19	0.14823	9.1712 -10
150	20	0.15120	9.1795 -10
160	21	0.15385	9.1870 -10
170	22	0.15625	9.1940 -10
180	23	0.15840	9.2000 -10
190	24	0.16035	9.2053 -10
200	25	0.16210	9.2100 -10
210	26	0.16367	9.2139 -10
$\sum_3$ log Y	-	-	82.7129 -90

TABLE XV-5

CALCULATION OF GOMPERTZ COEFFICIENTS
TEST 7 (HWS)

$$\Sigma_1 \log Y = 74.1360 - 90 = -15.8640$$

$$\Sigma_2 \log Y = 81.5866 - 90 = -\ 8.4134$$

$$\Sigma_3 \log Y = 82.7129 - 90 = -\ 7.2871$$

$$b^9 = \frac{1.1263}{7.4506} = 0.15117$$

$$\log b^9 = 9.1796 - 10 = -0.8204$$

$$\log b = -0.091156 = 9.908844 - 10$$

$$b = 0.796$$

$$\log a = 7.4506 \ \frac{(-0.204 \quad)}{(\ 0.72051)}$$

$$= -2.1095 = 7.8905 \ -10$$

$$\log m = \frac{1}{9}\left[-15.864 \ -\left(\frac{0.84883}{0.204}\right)\left(-2.1095\right)\right]$$

$$= -0.78739$$

TABLE XV-6

APPLICATION OF GOMPERTZ COEFFICIENTS
TEST 7 (HWS)

x	b^x	$(\log a)\ b^x$	$\log Y_c$	Y_c	ΔY_c
0	1.00000	-2.1095	-2.89689	.001268	-
1	0.79600	-1.67916	-2.46655	.003415	0.002147
2	0.63362	-1.33662	-2.12401	.007515	0.00410
3	0.50436	-1.06395	-1.85134	.01410	0.006585
4	0.40147	-0.84690	-1.63429	.02320	0.00910
5	0.31957	-0.67413	-1.46152	.03457	0.01137
6	0.25438	-0.53661	-1.32400	.04745	0.1288
7	0.20248	-0.42713	-1.21452	.06100	0.01355
8	0.16118	-0.34001	-1.12740	.07460	0.0136
9	0.12830	-0.27065	-1.05804	.08750	0.0129
10	0.10212	-0.21552	-1.00281	.09930	0.0118
11	0.08129	-0.17148	-0.95887	.1100	0.0107
12	0.06471	-0.13651	-0.92390	.1192	0.0092
13	0.05151	-0.10866	-0.89605	.1270	0.0078
14	0.04100	-0.08649	-0.87388	.1337	0.0067
15	0.03264	-0.06885	-0.85624	.1392	0.0055
16	0.02598	-0.05480	-0.84219	.1438	0.0046
17	0.02068	-0.04362	-0.83101	.1476	0.0038
18	0.01646	-0.03472	-0.82211	.1507	0.0031
19	0.01310	-0.02763	-0.81503	.1531	0.0024
20	0.01043	-0.02200	-0.80939	.1552	0.0021
21	0.00830	-0.01751	-0.80490	.1568	0.0016
22	0.00661	-0.01394	-0.80133	.1580	0.0012
23	0.00526	-0.01110	-0.79849	.1590	0.0010
24	0.00419	-0.00884	-0.79623	.1598	0.0008
25	0.00333	-0.00702	-0.79441	.1604	0.0006
26	0.00265	-0.00559	-0.79298	.1610	0.0006

TABLE XV-8

GOMPERTZ COEFFICIENTS FOR PLOTS OF "k_1" (VELOCITY COEFFICIENT IN BUILDUP CURVES) VERSUS LOCATION, AS DETERMINED BY EYE FIT OF THE CURVES BY ANALOG COMPUTER

High Water Slack Tests	Peak Location	m	ln b	-m ln b
1	-82	0.2869	-0.1826	0.0524
2	-26	0.2373	-0.2284	0.0542
3	27	0.1431	-0.1885	0.0270
4	117	0.1242	-0.2090	0.0260
5	138	0.1370	-0.1866	0.0256
3	27	0.1431	-0.1885	0.0270
7	20	0.1811	-0.1950	0.0353
6	26	0.2714	-0.2158	0.0586
8	27	0.3627	-0.1826	0.0662
9	27	0.4128	-0.2077	0.0857
Low Water Slack Tests				
1	-82	0.4427	-0.1859	0.0823
2	0	0.2620	-0.2147	0.0563
3	49	0.1603	-0.2020	0.0324
4	141	0.1444	-0.2094	0.0302
5	178	0.1340	-0.2048	0.0274
3	49	0.1603	-0.2020	0.0324
7	55	0.2308	-0.1569	0.0362
6	57	0.3324	-0.1650	0.0548
8	59	0.3668	-0.1538	0.0564
9	63	0.4645	-0.1570	0.0729

Peak Value = m a ln a ln b
ln a = -1 a = 0.3679

Peak Value = -0.3679 m ln b

TABLE XVI-1

DELAWARE RIVER MODEL TEST (HWS)
DIFFERENCE IN ULTIMATE BUILDUP *(Δ L)
BETWEEN SELECTED STATIONS AT VARIOUS STEADY STATE FLOWS**

30,000 Ft. Station Intervals

Flow cfs	50-80	80-110	110-140	140-170
3500	0.0160	0.0140	0.0130	0.0115
4000	0.0150	0.0130	0.0115	0.0105
4500	0.0135	0.0115	0.0105	0.0097
5000	0.0130	0.0110	0.0100	0.0090
5500	0.0120	0.0100	0.0090	0.0085
6000	0.0110	0.0095	0.0085	0.0077
6500	0.0100	0.0090	0.0080	0.0069
7000	0.0095	0.0085	0.0075	0.0065
7500	0.0090	0.0076	0.0070	0.0060
8000	0.0085	0.0070	0.0062	0.0058

*Ultimate Buildup values are recorded as percent of initial concentration

**Discharge point at station +50

TABLE XVI-2

DELAWARE RIVER MODEL TEST (HWS)
DIFFERENCE IN ULTIMATE BUILDUP *(Δ L)
BETWEEN SELECTED STATIONS AT VARIOUS STEADY STATE FLOWS
(EXPANDED RESULTS)

30,000 Ft. Station Intervals

Flow cfs	50-80	80-110	110-140	140-170
2000	0.02300	0.0182	0.0160	0.0145
2500	0.02050	0.0170	0.0150	0.0134
3000	0.01850	0.0155	0.0140	0.0125
3500	0.01610	0.01420	0.0130	0.01152
4000	0.01489	0.01270	0.01150	0.01053
4500	0.01385	0.01170	0.01055	0.00970
5000	0.01287	0.01090	0.00980	0.00900
5500	0.01193	0.01018	0.00915	0.00830
6000	0.01100	0.00952	0.00853	0.00766
6500	0.01020	0.00889	0.00797	0.00705
7000	0.00946	0.00827	0.00740	0.00651
7500	0.00888	0.00766	0.00686	0.00608
8000	0.00850	0.00705	0.00634	0.00570
Ultimate (Δ L)				
Flow 0	0.0280	0.0250	0.0220	0.0195

*Ultimate buildup values are recorded as percent of initial concentration

Note: Values from Fig. XVI-1

TABLE XVI-3

DELAWARE RIVER MODEL TEST (HWS)

TIME OF TRANSIT BETWEEN SELECTED STATIONS, TIDAL CYCLES

(FROM INSTANTANEOUS RELEASE TESTS, CHAPTER XII)

Flow cfs	30,000 Ft. Station Interval 50-80	80-110	110-140	140-170
3,400	18.5	21.5	25.5	28.5
5,500	15.0	16.0	16.7	17.2
12,350	5.4	6.7	7.0	7.1

TABLE XVI-4

DELAWARE RIVER MODEL TEST (HWS)

TIME OF TRANSIT BETWEEN SELECTED STATIONS (T), CYCLES

Flow cfs	30,000 Ft. Station Intervals 50-80	80-110	110-140	140-170
2,000	22.2	26.8	32.3	37.0
2,500	20.6	24.5	29.5	33.0
3,000	19.4	22.7	27.1	30.8
3,500	18.3	21.2	25.0	28.0
4,000	17.5	19.8	22.9	25.2
4,500	16.7	18.5	20.8	22.5
5,000	15.8	17.3	18.7	19.8
5,500	15.0	16.0	16.7	17.2
6,000	14.3	15.3	15.9	16.4
6,500	13.6	14.7	15.2	15.7
7,000	12.9	13.9	14.5	14.9
7,500	12.2	13.3	13.8	14.2
8,000	11.5	12.6	13.1	13.5

TABLE XVI-5

DELAWARE RIVER MODEL TEST (HWS)
CHANGE IN BUILDUP IN CONCENTRATION
EXPRESSED AS PERCENT OF PROJECTED MAXIMUM
FOR 30,000 FT STATION INTERVALS

Flow cfs	30,000 Ft. Station Intervals			
	50-80	80-110	110-140	140-170
2,000	0.8214	0.7280	0.7275	0.7435
2,500	0.7321	0.6800	0.6820	0.6870
3,000	0.6605	0.6200	0.6365	0.6410
3,500	0.5750	0.5680	0.5910	0.5910
4,000	0.5320	0.5080	0.5225	0.5400
4,500	0.4945	0.4680	0.4795	0.4975
5,000	0.4595	0.4360	0.4455	0.4615
5,500	0.4260	0.4070	0.4160	0.4255
6,000	0.3930	0.3810	0.3875	0.3930
6,500	0.3645	0.3560	0.3625	0.3615
7,000	0.3380	0.3310	0.3365	0.3340
7,500	0.3170	0.3065	0.3120	0.3120
8,000	0.3035	0.2820	0.2830	0.2925

Sample calculation:

Interval 50-80, flow 2,000 cfs

$$\frac{*\,0.0230}{*\,0.0280} = 0.8214\ \%$$

* See Table XVI-2

TABLE XVI-6

DELAWARE RIVER MODEL TEST (HWS)
PERCENT ORGANIC STABILIZATION AT DIFFERENT "k_1" VALUES

Time (Days)	"k_1"							
	0.02	0.025	0.03	0.04	0.05	0.072	0.10	0.15
1	4.5	5.61	6.69	8.76	10.90	15.35	20.5	29.23
2	8.76	10.90	12.88	16.88	20.60	28.3	36.9	49.90
3	12.88	15.90	18.76	24.16	29.23	39.2	49.9	64.40
4	16.88	20.60	24.16	30.82	36.91	48.6	60.2	74.95
5	20.59	25.05	29.23	36.92	43.80	56.4	68.4	82.25
6	24.16	29.23	33.95	42.50	49.90	62.9	74.8	87.43
7	27.58	33.23	38.40	47.56	55.40	68.8	80.1	91.10
8	30.82	36.92	42.50	52.20	60.20	73.5	84.1	93.70
9	33.95	40.53	46.38	56.40	64.60	77.6	87.4	95.55
10	36.92	43.80	49.90	60.22	68.42	81.0	90.0	96.84
11	39.76	47.00	53.35	63.72	71.88	84.0	92.06	97.76
12	42.50	49.90	56.40	66.95	74.95	86.4	93.71	98.42
13	45.05	52.79	59.40	69.83	77.65	88.5	95.00	98.88
14	47.56	55.40	62.05	71.50	80.10	90.3	96.03	99.05
15	49.90	57.95	64.60	74.95	82.25	91.6	96.84	99.44
18	56.40	64.60	71.25	81.00	87.40	94.9	98.42	99.80
20	60.22	68.42	74.95	84.10	90.00	96.4	99.02	99.90

Calculated from deoxygenation formula:

$$x = L\,(1 - C \cdot 10^{-k_1 t})$$

Where $L = 100$ and $C = 1.0$

TABLE XVI-7

DELAWARE RIVER MODEL TEST (HWS)
PER CENT ORGANIC MATTER
STABILIZATION WITHIN SEGMENT 50-80 AT VARIOUS DEOXYGENATION RATES

	"k_1"						
Flow cfs	0.02	0.03	0.04	0.05	0.072	0.10	0.15
2,000	40.0	53.6	63.9	71.9	84.2	92.2	97.7
2,500	37.7	50.9	61.2	69.3	81.8	90.6	96.9
3,000	36.0	49.1	59.2	67.2	80.1	89.3	96.3
3,500	34.2	47.0	57.0	65.2	78.1	87.7	95.4
4,000	33.0	45.7	55.5	63.8	76.7	86.6	94.9
4,500	31.8	44.0	53.7	61.9	75.0	85.2	94.1
5,000	30.3	42.2	51.8	60.0	73.1	83.7	93.2
5,500	29.0	40.6	50.0	58.1	71.1	82.2	92.3
6,000	27.9	39.0	48.3	56.2	69.2	80.7	91.4
6,500	26.8	37.4	46.0	54.2	67.3	79.0	90.3
7,000	25.7	36.0	45.0	52.6	65.7	77.2	89.3
7,500	24.6	34.2	43.0	50.5	63.6	75.3	87.9
8,000	23.7	33.1	41.8	49.0	62.0	73.9	86.7

TABLE XVI-8
DELAWARE RIVER MODEL TEST (HWS)
PERCENT ORGANIC MATTER
STABILIZATION WITHIN SEGMENT 80-110 AT VARIOUS DEOXYGENATION RATES

Flow cfs	"k_1" 0.02	0.03	0.04	0.05	0.072	0.10	0.15
2,000	46.1	60.8	70.9	78.6	89.2	95.5	99.1
2,500	43.0	57.3	67.5	75.2	87.0	94.0	98.5
3,000	40.7	54.6	64.8	72.7	84.8	92.6	97.9
3,500	38.7	52.1	62.2	70.3	83.0	91.3	97.3
4,000	36.4	49.6	59.9	67.9	80.7	89.7	96.4
4,500	34.6	47.8	57.5	64.7	78.6	88.0	95.7
5,000	32.7	45.2	55.0	63.2	76.3	86.2	94.7
5,500	30.6	42.7	52.5	60.5	73.6	84.0	93.5
6,000	29.5	41.2	51.0	59.0	71.9	82.8	92.7
6,500	28.5	39.9	49.2	57.2	70.2	81.5	92.0
7,000	27.3	38.2	47.5	55.3	68.4	80.0	91.0
7,500	26.3	36.9	45.9	53.6	66.7	78.3	90.0
8,000	25.2	35.1	44.0	51.6	64.7	76.5	88.7

TABLE XVI-9
DELAWARE RIVER MODEL TEST (HWS)
PER CENT ORGANIC MATTER
STABILIZATION WITHIN SEGMENT 110-140 AT VARIOUS DEOXYGENATION RATES

Flow cfs	"k_1"							
	0.02	0.025	0.03	0.04	0.05	0.072	0.10	0.15
2,000	52.5	60.4	67.1	77.1	84.3	92.8	97.6	99.7
2,500	49.5	57.2	63.0	74.2	81.7	91.2	96.8	99.6
3,000	46.6	54.3	61.2	71.2	79.0	89.5	95.6	99.2
3,500	43.8	51.5	58.7	68.3	76.0	87.6	94.3	98.7
4,000	40.9	48.4	55.0	65.0	72.8	85.0	92.3	98.0
4,500	38.0	45.2	51.2	61.6	69.7	82.2	90.8	97.0
5,000	34.9	41.7	47.7	57.9	66.1	78.9	88.3	95.8
5,500	31.8	38.4	44.1	53.9	62.0	75.0	85.3	94.2
6,000	30.5	36.9	42.5	52.0	60.2	73.4	84.0	93.8
6,500	29.3	35.5	41.0	50.5	58.5	71.6	82.5	92.6
7,000	28.2	34.3	39.6	48.8	56.7	70.0	81.1	91.7
7,500	27.1	33.0	38.0	47.0	55.0	68.0	79.6	90.7
8,000	26.0	31.6	36.4	45.3	52.9	66.0	77.7	89.6

TABLE XVI-10

DELAWARE RIVER MODEL TEST, (HWS) PERCENT ORGANIC MATTER STABILIZATION WITHIN SEGMENTS 140-170 AT VARIOUS DEOXYGENATION RATES

Flow (cfs)	"k1"						
	0.02	0.03	0.04	0.05	0.072	0.10	0.15
2,000	57.4	72.3	81.8	88.1	95.0	98.7	99.8
2,500	54.0	68.9	78.7	85.5	93.6	98.0	99.8
3,000	50.8	65.4	75.6	83.0	92.0	97.1	99.7
3,500	47.7	62.2	72.5	79.8	89.8	95.6	99.4
4,000	44.0	58.3	69.0	76.8	87.8	94.4	98.7
4,500	40.4	54.2	64.4	72.3	84.6	92.5	97.9
5,000	36.4	49.7	60.3	68.5	80.7	89.7	96.5
5,500	32.5	45.0	55.9	64.2	76.0	86.0	94.6
6,000	31.2	43.4	53.1	61.3	74.5	84.8	93.8
6,500	30.0	42.0	51.6	59.7	72.9	83.5	93.1
7,000	28.9	40.5	49.6	57.7	71.0	82.0	92.3
7,500	27.9	39.0	48.0	56.0	69.0	80.5	91.3
8,000	26.7	37.2	46.3	54.0	67.1	78.9	90.3

TABLE XVI-11
DELAWARE RIVER MODEL TEST (HWS)
AVERAGE ULTIMATE BUILDUP CONCENTRATION, (PERCENT)
WITHIN VARIOUS SELECTED SEGMENTS

	SEGMENT			
Flow cfs	50-80	80-110	110-140	140-170
2000	0.1660	0.1468	0.1298	0.1135
2500	0.1525	0.1348	0.1190	0.1044
3000	0.1410	0.1245	0.1100	0.0966
3500	0.1292	0.1145	0.1014	0.0895
4000	0.1195	0.1055	0.0933	0.0824
4500	0.1102	0.0975	0.0867	0.0764
5000	0.1022	0.0905	0.0801	0.0707
5500	0.0950	0.0840	0.0744	0.0658
6000	0.0884	0.0781	0.0690	0.0610
6500	0.0820	0.0725	0.0640	0.0566
7000	0.0764	0.0674	0.0596	0.0528
7500	0.0708	0.0629	0.0556	0.0492
8000	0.0664	0.0586	0.0519	0.0459
Ultimate	0.0226	0.200	0.176	0.155

TABLE XVI-12

DELAWARE RIVER MODEL TEST, (HWS)
RELATIVE AMOUNTS OF UNSTABILIZED ORGANIC MATTER (PERCENT OF INITIAL CONCENTRATION) WITHIN SEGMENT 50-80 AT VARIOUS DEOXYGENATION RATES

Flow (cfs)	"k_1" 0.02	0.03	0.04	0.05	0.072	0.10	0.15
2000	0.0996	0.0770	0.0599	0.0466	0.0262	0.0129	0.0038
2500	0.0950	0.0749	0.0592	0.0468	0.0278	0.0143	0.0047
3000	0.0902	0.0718	0.0575	0.0462	0.0279	0.0151	0.0052
3500	0.0850	0.0685	0.0556	0.0450	0.0283	0.0159	0.0059
4000	0.0801	0.0649	0.0532	0.0433	0.0278	0.0160	0.0061
4500	0.0752	0.0617	0.0510	0.0420	0.0276	0.0163	0.0065
5000	0.0712	0.0591	0.0493	0.0409	0.0275	0.0167	0.0069
5500	0.0675	0.0564	0.0475	0.0398	0.0275	0.0169	0.0073
6000	0.0637	0.0539	0.0457	0.0387	0.0272	0.0170	0.0076
6500	0.0600	0.0513	0.0443	0.0376	0.0268	0.0172	0.0080
7000	0.0568	0.0489	0.0420	0.0362	0.0262	0.0174	0.0082
7500	0.0534	0.0466	0.0404	0.0350	0.0258	0.0175	0.0086
8000	0.0507	0.0444	0.0386	0.0339	0.0252	0.0173	0.0088

Example of calculation:

for $k = 0.04$, flow = 3,000 cfs.

From Figure XVI-1 or Table XVI-11, the average ultimate buildup (L) in segment 50-80 = 0.1410

Percent organic matter stabilized = 59.2%
(from Figure XVI-6 or Table XVI-8)

Relative amount of organic matter unstabilized:

$$= 0.1410\ (1.0 - 0.592) = 0.0575\%$$

TABLE XVI-13

DELAWARE RIVER MODEL TEST, (HWS) RELATIVE AMOUNTS OF UNSTABILIZED ORGANIC MATTER (PERCENT OF INITIAL CONCENTRATION) WITHIN SEGMENT 80-110 AT VARIOUS DEOXYGENATION RATES

Flow (cfs)	"k_1"						
	0.02	0.03	0.04	0.05	0.072	0.10	0.15
2000	0.0791	0.0575	0.0427	0.0313	0.0159	0.0066	0.0013
2500	0.0768	0.0576	0.0438	0.0334	0.0175	0.0081	0.0020
3000	0.0740	0.0567	0.0440	0.0341	0.0191	0.0094	0.0028
3500	0.0702	0.0548	0.0433	0.0340	0.0195	0.0100	0.0031
4000	0.0671	0.0532	0.0423	0.0339	0.0204	0.0109	0.0038
4500	0.0638	0.0509	0.0414	0.0344	0.0209	0.0117	0.0042
5000	0.0609	0.0496	0.0407	0.0333	0.0214	0.0125	0.0048
5500	0.0583	0.0481	0.0399	0.0332	0.0222	0.0134	0.055
6000	0.0551	0.0459	0.0383	0.0320	0.0219	0.0134	0.0057
6500	0.0518	0.0436	0.0368	0.0310	0.0216	0.0134	0.0058
7000	0.0490	0.0417	0.0354	0.0301	0.0213	0.0135	0.0061
7500	0.0464	0.0397	0.0340	0.0292	0.0209	0.0136	0.0063
8000	0.0438	0.0380	0.0328	0.0284	0.0207	0.0138	0.0066

Note: See Table XVI-12 for sample calculation.

TABLE XVI-14

DELAWARE RIVER MODEL TEST (HWS)
RELATIVE AMOUNTS OF UNSTABILIZED ORGANIC MATTER (PERCENT OF INITIAL CONCENTRATION) WITHIN SEGMENT 110-140 AT VARIOUS DEOXYGENATION RATES

	SEGMENT 110 - 140							
	"k_1"							
Flow cfs	0.02	0.025	0.03	0.04	0.05	0.072	0.10	0.15
2000	0.0617	0.0514	0.0427	0.0297	0.0204	0.0093	0.0031	0.0004
2500	0.0601	0.0509	0.0440	0.0307	0.0218	0.0105	0.0038	0.0005
3000	0.0587	0.0503	0.0427	0.0317	0.0231	0.0116	0.0048	0.0009
3500	0.0570	0.0492	0.0419	0.0321	0.0243	0.0126	0.0058	0.0013
4000	0.0551	0.0481	0.0420	0.0327	0.0254	0.0140	0.0072	0.0019
4500	0.0538	0.0475	0.0423	0.0333	0.0263	0.0154	0.0080	0.0026
5000	0.0521	0.0467	0.0419	0.0337	0.0272	0.0169	0.0094	0.0034
5500	0.0507	0.0458	0.0416	0.0343	0.0283	0.0186	0.0109	0.0043
6000	0.0480	0.0435	0.0397	0.0331	0.0275	0.0184	0.0110	0.0043
6500	0.0452	0.0413	0.0378	0.0317	0.0266	0.0182	0.0112	0.0047
7000	0.0428	0.0392	0.0360	0.0305	0.0258	0.0179	0.0113	0.0049
7500	0.0405	0.0373	0.0345	0.0295	0.0250	0.0178	0.0113	0.0052
8000	0.0384	0.0355	0.0330	0.0284	0.0244	0.0176	0.0116	0.0054

Note: See Table XVI-12 for sample calculation

TABLE XVI-15

DELAWARE RIVER MODEL TEST, (HWS)
RELATIVE AMOUNTS OF UNSTABILIZED ORGANIC MATTER (PERCENT OF INITIAL CONCENTRATION) WITHIN SEGMENT 140-170 AT VARIOUS DEOXYGENATION RATES

Flow (cfs)	"k_1"						
	0.02	0.03	0.04	0.05	0.072	0.10	0.15
2000	0.0484	0.0314	0.0207	0.0135	0.0057	0.0015	0.0002
2500	0.0480	0.0325	0.0222	0.0151	0.0067	0.0021	0.0002
3000	0.0475	0.0334	0.0236	0.0164	0.0077	0.0028	0.0003
3500	0.0468	0.0338	0.0246	0.0181	0.0091	0.0039	0.0005
4000	0.0461	0.0344	0.0255	0.0191	0.0101	0.0046	0.0011
4500	0.0455	0.0350	0.0272	0.0212	0.0118	0.0057	0.0016
5000	0.0450	0.0356	0.0281	0.0223	0.0136	0.0073	0.0025
5500	0.0444	0.0362	0.0290	0.0236	0.0158	0.0092	0.0036
6000	0.0420	0.0345	0.0286	0.0236	0.0156	0.0093	0.0038
6500	0.0396	0.0328	0.0274	0.0228	0.0153	0.0093	0.0039
7000	0.0375	0.0314	0.0266	0.0223	0.0155	0.0095	0.0041
7500	0.0355	0.0300	0.0256	0.0216	0.0153	0.0096	0.0043
8000	0.0336	0.0288	0.0246	0.0211	0.0151	0.0097	0.0045

Note: See Table XVI-12 for sample calculation.

TABLE XVI-16

DELAWARE RIVER MODEL TEST, SERIES 3, 7, 6, 8, & 9, (HWS) RELATIONSHIP OF TEMPERATURE & DEOXYGENATION CONSTANT "k_1"

k_1	T°C	T°C	T°C
0.020			0.10
0.025			5.00
0.030		1.00	8.90
0.040	0.10	7.63	15.66
0.050	4.95	12.07	20.00*
0.072	12.86	20.00*	27.93
0.100	20.00*	27.17	35.10
0.150	28.82	36.00	43.90

*Each temperature series was derived after first assuming a particular deoxygenation constant at 20°C.

Sample Calculation:

Assume: $k_{20} = 0.10$

$k_T = 0.72$

then .072 $= k_{20}(1.047)^{T=20}$

$T = 12.86°C$

TABLE XVIII-5

BUILDUP* OF 5-DAY B.O.D. (p.p.m.)
BY GEOMETRIC SERIES AT 3,000 CFS STEADY STATE FLOW
AND DEOXYGENATION RATE OF 0.1

Discharge Station	Effect of Discharge at Station No.						
	5	35	65	95	125	155	185
5	2.33	0.39	0.05				
35	1.94	2.83	0.35	0.03			
65		3.53	4.78	0.41	0.03		
95			1.52	1.88	0.14	0.01	
125				1.32	1.42	0.10	0.01
155					0.81	0.97	0.05
185						0.25	0.30
Total	4.27	6.75	6.70	3.64	2.40	1.33	0.36

*HWS and Loadings based on modified Estimates. (see Table XVIII-4)

TABLE XVIII-6

BUILDUP* OF 5-DAY B.O.D. (p.p.m.)
BY GEOMETRIC SERIES AT 5,000 CFS STEADY STATE FLOW
AND DEOXYGENATION RATE OF 0.1

Discharge Station	Effect of Discharge at Station No.						
	5	35	65	95	125	155	185
5	2.02	0.62	0.16	0.02			
35	1.41	2.48	0.62	0.09	0.01		
65		3.08	4.45	0.66	0.09	0.01	
95			1.26	1.81	0.24	0.03	
125				1.01	1.38	0.17	0.03
155					0.72	0.95	0.11
185						0.22	0.29
Total	3.43	6.18	6.49	3.59	2.44	1.38	0.43

*HWS and Loadings based on modified Estimates.

TABLE XVIII-7

BUILDUP* OF 5-DAY B.O.D. (p.p.m.)
BY GEOMETRIC SERIES AT 7,000 CFS STEADY STATE FLOW
AND DEOXYGENATION RATE OF 0.1

Discharge Station	Effect of Discharge at Station No.						
	5	35	65	95	125	155	185
5	1.92	0.66	0.20	0.04			
35	1.29	2.36	0.71	0.14	0.02		
65		2.67	4.19	0.81	0.15	0.02	
95			1.12	1.72	0.31	0.05	0.01
125				0.93	1.33	0.22	0.03
155					0.66	0.93	0.14
185						0.21	0.28
Total	3.21	5.69	6.22	3.64	2.47	1.43	0.46

*HWS and Loadings based on modified Estimates.

TABLE XVIII-8

BUILDUP* OF 5-DAY B.O.D. (p.p.m.)
BY GEOMETRIC SERIES AT 5,000 CFS STEADY STATE FLOW
AND DEOXYGENATION RATE OF 0.075

Discharge Station	Effect of Discharge at Station No.						
	5	35	65	95	125	155	185
5	2.34	0.94	0.32	0.07	0.02		
35	1.51	2.90	0.99	0.24	0.05	0.01	
65		3.22	5.40	1.25	0.26	0.05	0.01
95			1.41	2.25	0.48	0.10	0.02
125				1.13	1.72	0.35	0.07
155					0.83	1.22	0.23
185						0.26	0.28
Total	3.85	7.06	8.12	4.94	3.36	1.99	0.61

*HWS and Loadings based on modified Estimates.

TABLE XVIII-9

BUILDUP* OF 5-DAY B.O.D. (p.p.m.) BY GEOMETRIC SERIES AT 5,000 CFS STEADY STATE FLOW AND DEOXYGENATION RATE OF 0.125

Discharge	Effect of Discharge at Station No.						
Station	5	35	65	95	125	155	185
5	1.76	0.42	0.08	0.01			
35	1.31	2.12	0.39	0.04			
65		2.79	3.74	0.35	0.03		
95			1.13	1.48	0.12	0.01	
125				0.89	1.12	0.09	0.01
155					0.65	0.71	0.05
185						0.20	0.24
Total	3.07	5.33	5.34	2.77	1.92	1.01	0.30

*HWS and Loadings based on modified Estimates.